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Cables :: "Stomata." | Phone :: 2183

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COORDINATION IN EMPIRE AGRICULTURAL RESEARCH.

THE title given to the British Commonwealth Scientific Conference which was held in London during September and October of last year was somewhat misleading. In the original plans for this Conference discussion on such matters as the organization of Industrial Research, on nutrition, and on other problems of human health was contemplated but in the final agenda only the sciences relating to agriculture were to any extent considered. Even when confined to these limits the field covered was a large and interesting one. The Conference, however, chiefly reviewed the research projects dealt with in the report to Governments by the Executive Council of the Imperial Agricultural Bureaux. It will be recollected that these subjects were referred to therein by the Committee on Economic Consultation and Cooperation formed in 1932 as a result of a recommendation made by the Prime Minister of Canada at the Imperial Economic Conference at Ottawa in 1932. It will further be remembered that the scale of charges by which the various governments in the Commonwealth of the British Empire were to support the Imperial Economic Committee, the Imperial Shipping Committee and the Executive Council of the Imperial Agricultural Bureaux was laid down for a period of three years. Thus, the year 1936 was the appropriate time to review the activities of these bodies.

The delegates of the Commonwealth Scientific Conference were mainly concerned with the position of the Agricultural Bureaux and the associated scientific institutes.

The original Bureaux were those for Entomology and Mycology and when the eight new Agricultural Bureaux were established in 1927 to cover the subjects of soil science, animal health, animal nutrition, animal genetics, plant genetics (other than herbage), plant genetics (herbage), fruit production and agricultural parasitology, the two old Bureaux became Institutes. These Institutes have considerably wider functions than those of the eight Bureaux, which confine themselves largely to the collection and dissemination of information to scientific workers throughout the Empire.

The service provided by these Bureaux has undoubtedly been of the greatest assistance to scientific workers and to government agricultural departments generally throughout the British

Empire and there is little doubt that the continuance of the scheme will probably be recommended by the Conference. After five years experience there will inevitably be much to be done to make the machinery of the Bureaux more efficient and more smooth working. An increase in the financial aid from the various subscribing countries may be difficult at the present time but it may prove possible to increase the revenue from the sales of periodicals by revising the free distribution list and by increasing sales through judicious advertisement. Another suggestion is that charges should be made for translations of any special articles that are asked for by a particular Government or an individual worker. In many of the subjects dealt with the literature has increased greatly in the last few years owing to the much wider extension of scientific investigations that has developed in certain countries which, until quite recently, had not the facilities nor were particularly interested in this type of work. As a result, the individual Bureau is faced with the task of abstracting in many more languages than were originally contemplated. The increased interest in agricultural science shown by such countries as Russia, Japan and Poland has thrown an additional strain on the resources of the Bureaux. This fact will possibly prove a conclusive reason why most of them will continue to remain domiciled in Great Britain. Under the present organisation there is no rule to prevent Bureaux from being located in any of the other Empire countries except that it is this difficulty of getting articles in the more unusual languages properly abstracted that will tend to keep the Bureaux in the United Kingdom for the time being. In the Home country the same difficulty in getting good abstracts done at a reasonable cost is not so acute as it possibly would be in one of the Dominions or in India. The United Kingdom is certainly also the most convenient centre for overseas workers to assemble. It is of course possible that it may be found feasible to remove one of the existing Bureaux to some other part of the Empire which happens to possess special advantages. If this could be done without impairing general efficiency, it would undoubtedly be a step in the right direction and would help to cement the interest in this cooperative effort.

There are other ways in which assistance could be given to the Bureaux such as by instituting better means of distributing the literature. It is possible that the establishment of a system of official correspondents for each homogenous area might do much to relieve the secretary and staff of each Bureau of the necessity of replying to a number of queries which in some cases may be irrelevant or in others could be perfectly well answered on the spot by direct reference to a local institution. The question of overlap between the different Bureaux is a difficult one and needs attention. It has been suggested for example that there may be some measure of duplication between the two Bureaux of plant genetics since although the Aberystwyth Bureau deals with herbage plants and the one at Cambridge with non-herbage plants, there must be much literature covering the principles of genetics or cytology which could reasonably be said to come under the scope of both. Instances of this kind are bound to occur and it would appear to be important therefore that the Deputy Directors of the Bureaux should keep in close touch with each other and if possible exchange frequent visits so as to eliminate any overlap of this sort.

There is little doubt that the system of placing a Bureau alongside the appropriate Research Institution and of making the Director of the Institution also Head of the Bureau has worked well in the past as it has enabled the staff to keep in the closest possible touch with recent scientific investigations.

It is appropriate that reference should be made here to the organisation that so ably controls the Bureaux. The Executive Council of the Imperial Agricultural Bureaux furnishes a model of cooperative effort among the Commonwealth of the Nations of the British Empire which might well be adopted in other directions. The United Kingdom equally with the several Dominions, India and the Colonial Empire has the right to nominate one member to the Council. The Chairman is elected by the members annually and the position is held in rotation. The funds placed at the disposal of the Council are contributed on an equal basis by the several governments represented on the Council which supervises the work and finances of the various Agricultural Bureaux and Institutes under its charge. Members of the Council are naturally not equally interested in all the Bureaux. The individual Colonies for example are usually not so well staffed as the larger Dominions and are vitally interested therefore in the work of the Entomological and Mycological Institutes in particular. On the other hand, they are frequently not so directly concerned with a Bureau such as the one dealing with non-herbage plants which is of particular importance to livestock raising Dominions such as New Zealand and Australia. Considering the British Empire as a whole, however, it is realised that all these Bureaux are doing essential work for one part or another and that a strong cooperative effort is therefore needed to keep them all in being. If it is found possible to raise more contributions on the above basis there is little doubt that one or two more Bureaux could be usefully established. A Bureau to abstract forestry literature is urgently needed and has in fact been stressed by successive forestry conferences since the War. Similarly there is a need for a Dairy Bureau although the scope of such an institution would have to be very carefully defined if it were not to overlap in certain directions with the work of some of the other Bureaux.

Space forbids mention of several other matters discussed at the Conference but the suggestion that a general agricultural conference should be

held is unlikely to be accepted without a good deal of discussion. Its scope in any case would have to be very clearly defined. Moreover the branches of scientific and applied agriculture are now so many and so wide, that it would seem doubtful whether such a conference would be practicable. There is plenty of room for periodic conferences on special branches and this system has already become well established as for instance in the case of entomology and mycology. There will also undoubtedly be need for a further review of the system of Agricultural Bureaux in a few years' time when the contributions come up for further renewal, since the limits of their usefulness has by no means been reached and with expansion new problems of administration are bound to arise.

G. E.

NOTES ON THE YELLOW APHIS OF SUGAR-CANE *SIPHA FLAVA* FORBES.

By F. A. Squire,
Entomologist to Agricultural Advisory Department.

This insect was first described from Illinois in 1883 as *Chaitophorus flavus* by Dr. Forbes, then State Entomologist. In 1909 J. J. Davis (2) removed it to the genus *Sipha* of Passerini where it rightly belongs.

In the meantime the species was recorded from several parts of the United States, revealing a general distr bution east of the Mississippi. There is good reason to suppose that it was introduced on Uba cane from the Southern States into Puerto Rico where it is now a thorn in the sugar planter's side. In 1927 it was recorded for the first time from British Guiana (1). Since then it has become more and more serious each year.

Besides sugar-cane and sorghum, a number of other Gramineae has been recorded in the United States as food plants including *Zea Mais* which is not, however, attacked in British Guiana. The absence of alternative food plants in the latter country is strong evidence that the pest is not indigenous.

It is interesting to compare the life history of *Sipha flava* in Illinois with that in British Guiana. Davis gives a detailed account of its biology in the United States and I am indebted to him for the information used here. The most striking difference is the complete loss in British Guiana of the winter or sexual generation together with the male sex, leaving only the alate and the wingless parthenogentic viviparous females to propagate the species. The wingless form predominates and as a rule alate females are found only on crowded leaves or as solitary individuals starting a new colony. Their appearance is not cyclic as the apterous females can propagate indefinitely without the intervention of the winged cast.

Other minor differences occur in the length of the life cycle and the rate of reproduction. Table I gives a comparative summary.

Table I.

	Maturation period (*i.e.*, life cycle)	Reproductive period.	Length of life.	Total average production per female.	Average rate of reproduction.
Illinois	7-31 days average 13.3 days	Max. 52 days average 27.6 days	Max. 101 days average 49.6 days	61.9 nymphs.	2.5 per day
British Guiana	4 days	about 20 days	about 30 days	about 60 nymphs.	3 per day

It will be seen that maturation only takes half the time in the tropics and that the span of life is shorter but that the total reproduction is the same. In both cases there are four moults—in Illinois one every second day or at longer intervals as compared with one every day in British Guiana.

In the latter country the pest is co-extensive with sugar-cane and occurs throughout the coastal belt of the provinces of Demerara and Berbice. It is decidedly seasonal, however, occurring during the solstitical rainy seasons only, generally in an acute and patchy form, so that blocks of fields are singled out here and there along the coast. Factors conducive to outbreaks are prolonged rains, high humidity and little or no sunshine. In certain years such conditions are not fulfilled: thus in 1934 the rainfall was only 81.04″, with 28″ in January, during which flood conditions unfavourable to insect life obtained. The wet months of June and December had only 9.21″ and 5.63″ respectively, both being well below the average. In that year there were no outbreaks of cane lice.

All stages of the cane are attacked and the damage done varies a good deal with the age of the stand. Young plants up to four months are sometimes killed or rendered useless by severe attacks while older fields may be considerably retarded. In Puerto Rico according to Wolcott (3) Uba cane is most severely damaged, the other varieties sustaining the same injury as the common Diamond and P.O.J. varieties grown in British Guiana.

Wolcott considers that the death of the leaves is due not merely to the removal of sap but almost certainly to the injection of toxins by the aphis. This view is not particularly well supported by field observations in British Guiana since even crowded infestations are slow in killing the leaf and small colonies do not set up any toxic symptoms.

Infestation is confined to the underside of the leaf. There is little in the structure of the cane blade to account for this preference and it seems

likely that the "lice" seek the underside for the sake of the shelter it affords. Experiments in which the leaves were tied over so as to bring the underside uppermost indicate that at all events the aphid's desire for shelter is stronger than any preference it may have for the underside of the leaf.

During the equinoctial dry seasons the aphis disappears almost entirely but may be found by diligent searching in small colonies closely attended by the ant *Solenopsis* on badly cultivated peasant canes. It is therefore subject to very vigorous selection and it would not be surprising if in time it became more tolerant of dry conditions, and consequently of greater economic importance in British Guiana.

The incidental lack of sunshine during the rains greatly favours the aphis. Laboratory experiments demonstrate a marked preference of the aphis for plants deficient in chlorophyll, so much so that they will flock on to chlorotic leaves or patches. Infestations can be produced without inoculation by simply keeping the plants indoors. Such infestations are generally dissipated by subsequent exposure to sunlight.

There are no known parasites of the cane-aphis in British Guiana, though predaceous enemies abound. These are discussed by Cleare (1). The sugar planter's greatest friends are the lady-birds, particularly *Neda sanguinea* and *Megilla maculata*. They are limited in their scope, however, since they do not thrive in conditions that most suit the aphis.

The utilization of contact insecticidal dusts or sprays in tall or bushy cane is out of the question especially in view of the sheltered position of the "lice" and the impracticability of introducing heavy spraying machinery into the fields. In the case of young plants spraying has been successfully carried out with knap-sack or pressure-pump sprayers fitted with upturned nozzles; the spray used was:—

Nicotine sulphate	.... 1 pint.
Molasses	.... 100 gals.
Water	.... 100 gals.
Soap	.... $2\frac{1}{2}$ lb.
Copper sulphate	.... $\frac{1}{2}$ lb.

The soap was necessary to overcome the aphid's waxy coating and copper sulphate was added to keep down the subsequent growth of black mould (Capnodium) on the molasses.

Attention to the question of manuring is likely to bear useful results, especially the application of nitrogenous fertilizers in adequate proportions so as to stimulate the production of chlorophyll.

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(1) Cleare, L. D. 1928.—Notes on an outbreak of Yellow Sugar-cane aphis. *Agric. Jl. of Brit. Guiana*, Vol. I, No. 3, pp. 149-150.

(2) Davis, J. J. 1909.—Biological studies on three species of Aphididae. *U.S.D.A., B.E., Tech. Ser.* 12, pt. 8.

(3) Wolcott, G. N. 1933.—An economic entomology of the West Indies. San Juan, Puerto Rico.

SOME IMPORTANT PARASITES OF SHEEP FROM BRITISH GUIANA.

By H. V. M. Metivier, O.B.E., B.Sc., M.R.C.V.S.

In 1935, I received from Dr. Giglioli of the League of Nations Commission to the Rupununi district of British Guiana, portions of the viscera of a sheep, preserved in formalin. In the alimentary tract four nematodes were found, and although all four are species known from many parts of the tropics, none has been previously reported from that district and it seems desirable to place them on record.

Haemonchus contortus.—The twisted wire worm —was found in the abomasum. This is one of the most serious roundworms of sheep in all tropical and sub-tropical countries as well as many temperate ones. It is a blood-sucker, has a blood-red colour and is about an inch or so long. Its popular name comes from the fact that the genital tubes of the female form a spiral round the intestine and are visible through the cuticle.

Trichostrongylus instabilis.—This is one of a group of nematodes called the "Bankrot" worms by South African farmers, because of the serious losses they cause there. It is a very small colourless nematode living in the first part of the small intestine and its distribution is well nigh universal. It is so small however, that it is generally overlooked on casual observation.

Monodontus trigonocephalus.—The sheep hookworm is also universally distributed. It is a tissue feeder and causes disease analogous to that caused in man by the human hookworms. It lives in the middle part of the small intestine, is colourless or occasionally pale pink and is easily visible to the naked eye.

Oesophagostomum columbianum.—The nodular worm was found in the large intestine. It is a white nematode which is easily seen with the naked eye. The adults appear to do little damage but the young stages live in nodules in the mucosa of the large intestine. If few in number, they cause little damage beyond rendering the intestine useless as sausage casings; if many, however, they may cause the death of the sheep. They are particularly serious in lambs and are regarded as major parasites of lambs in South Africa where they are frequently the direct cause of death. While essentially parasites of tropical and sub-tropical countries, they also occur in lands with a hot summer—such as Canada and the United States.

No other worms were found in the viscera of this animal but these four are among the most serious of all the round worms affecting sheep and would lead to certain trouble if sheep-breeding were ever carried out on an extensive scale in the Rupununi District of British Guiana.

These identifications were confirmed by Dr. T. W. M. Cameron, M.R.C.V.S., Director of the Institute of Parasitology, Canada, who was present in Trinidad when I received the material. I am indebted to him for his assistance in this matter.

THE CONTROL OF FROGHOPPER BLIGHT.*

By Alan Pickles, M.Sc.,
Entomologist to the Trinidad Department of Agriculture.

Trinidad, by being subject to the attacks of the Sugar cane Froghopper, has the unenviable distinction of possessing what may be regarded as the second worst insect pest in the world By this I mean to say that the froghopper is respons ble in certain years for the loss of a greater proportion of a single country's production of a particular commodity than any other insect with the exception of the Cotton Boll Weevil.

From the published records, it appears that froghopper blight has been known in the colony since the year 1862, but the froghopper was not recognised as the initial cause of the trouble until 1889. Since that time, the froghopper problem has been the subject of a vast amount of investigation, in which the services of entomologists with world-wide reputations have been engaged; among these, I may mention Mr. J. C. Kershaw, Dr. Gough, Dr. C. B. Williams and Mr. F. W. Urich. In spite of the great amount of painstaking research which has taken place, the Trinidad sugar industry is still largely at the mercy of the froghopper pest, partly due to the extreme complexity of the problem and partly on account of the difficulty of applying the ordinary control measures in such a crop as sugar-cane, for economic as well as for mechanical reasons.

Our knowledge of the problem, however, has increased very considerably and I hope to indicate to you this afternoon, the ways in which froghopper damage can be prevented or minimised, as an outcome of the accumulated results of investigation.

Before dealing with the practical measures to be adopted in combating froghoppers and blight, I should like to consider in some detail the sequence of events which occurs, culminating in the condition known as blight and also to examine with you the subsequent developments.

The eggs of the froghopper are laid in the soil of cane fields, where they may be found from the surface down to a depth of about four inches. Some eggs, especially in very wet weather, are laid in cane trash, but in such small numbers that they are of little practical significance. Our experiments on this point, extending over twelve months, have shown that only about one per cent. of the eggs are laid in cane trash.

Accordingly, it is not surprising to find that the type and condition of the cane soil affect the number of froghoppers which develop. A female froghopper which has only unfavourable soil in which to lay her eggs, will die retaining most of them in her body, rather than lay them in an unsuitable medium. A number of soil types and of soils in various conditions have been examined from this aspect, and in general, it may be said that heavy, compacted clay soils are more suitable for laying than are sandy soils; the former, accordingly, are more subject to heavy froghopper attacks than are the latter. Similarly, most soils are more suitable for egg laying when they are wet than they are when dry or merely moist, when compacted than when in a good tilth condition.

At the beginning of these studies, it was hoped that it might be possible to protect fields against froghopper attack by cultivation methods which would maintain the soil in a condition unsuitable for froghopper oviposition. Unfortunately, further experience showed that a very small change in the soil condition, far too small to be regulated by mass cultivation methods, could make all the difference between susceptibility and immunity of an area. A case in point occurred in 1931 at Orange Grove Estate, where one field had been entirely free from froghoppers for many years, although surrounded by fields of similar soil which were regularly blighted. It was found by a long series of observations, that the moisture content of the blighted fields was from four to eight per cent. higher than in the case of the unattacked field. While this work was in progress, the soil of the unattacked field increased in humidity relative to the surrounding fields, for some very obscure reason, and ultimately the soil moisture content exceeded that of the blight-subject fields. A few weeks later, this field, previously unattacked, became quite seriously affected with froghoppers.

In some cases where, from the point of view of freedom from froghopper attack, a field may be regarded as possessing extremely "good" soil, a bigger change in conditions is necessary to make the field susceptible to attack. Such cases, unfortunately, are by way of being exceptional, but are by no means unknown. The standard example is found in the Naparima black marl soils, which are regarded as immune from froghopper attack. When these soils are waterlogged however, at a time when froghoppers are migrating from surrounding susceptible fields, they are found to be eminently suitable for froghopper oviposition and in such a case, they may be severely blighted. This has been shown by several years' experience in the field, as well as by critical laboratory experiment.

* An address delivered to the Cultivation Committee of the Sugar Manufacturer's Association on the 18th August, 1936.

While the amelioration of poor soil conditions, then, cannot insure against froghopper attack, it may in some cases have a decidedly beneficial effect in the protection of the canes.

Of the eggs laid in the soil, a proportion will hatch about a fortnight after laying, giving rise to the nymphs which are familiar to all cane growers. These feed on the cane roots especially those near the soil surface, but nymphs in various stages of development may be found as deep as six inches or more below the soil surface, especially in the case of the first brood. Experiment has shown that of this brood, as much as 80 per cent. may be concealed beneath the soil. Even in the case of later broods, it is not uncommon to find, on digging up an infested stool, that nymphs are present in quantity underneath the base of the stool.

The effect of nymphal feeding, however, is not of great importance in practice. Doubtless some of the roots are killed, but it is found that when, through natural or artificial means, the adult froghoppers resulting from a large nymphal population are killed as fast as they emerge, the canes suffer no perceptible ill effects. I have had cases brought to my notice of canes suddenly yellowing at the time of nymphal attack, but such cases have been more readily explicable in terms of waterlogging coincident with the nymphal outbreak.

It is now generally recognised that the adults which develop from the nymphs are the prime cause of blight. The adults feed on the green leaves of the canes by puncturing the surface of the leaf and sucking out the juices. As in the case of most sucking insects, the froghopper pumps saliva into the wound which it has made. This causes digestion of the food while it is still within the plant, and it is sucked up after a certain amount of digestion has taken place. In consequence, especially since more saliva is injected into the plant than is required to digest the food taken out, breakdown of the plant tissues continues for some time after the insect has ceased to feed at that particular spot.

As a result of the injection of saliva into the leaf, the cells in the neighbourhood of the puncture begin to break down and a small, yellowish streak develops along the major axis of the leaf, near the original puncture. This increases in length and its centre begins to turn a reddish brown. Later, when the damaged area has attained a length of anything from one to three inches or more, elongation of the streak ceases or slows down, and the damaged tissue becomes trash coloured and dry.

A greater or smaller proportion of the leaf area is destroyed in this way, according to the number of froghopper adults present. Frequently, the blight streaks join up together and in moderately severe attacks, half of the total leaf area may be destroyed; in very severe attacks, practically the whole leaf area is involved in blight streaks.

Subsequent developments are somewhat uncertain. In some cases, even after severe blight, growth of the cane continues with relatively little check. New leaves are produced in the ordinary way, which replace those damaged by the insects and the plant is said to "make good recovery". In all cases, however, where a large proportion of the leaf area has been damaged there is a check to growth, which can be detected later when the cane stalk is examined: the joints produced at the time of blighting are seen to be thinner and shorter than usual, while the subsequent recovery leaves its mark in the shape of joints more nearly approaching normal dimensions.

More usually, further complications occur after severe blight has developed, sometimes also when blight has not been particularly severe. The damaged leaves begin to wilt at the tip and a similar wilting commences down the margin of the leaf, working gradually inwards, until the whole leaf blade is brown and dry. While this condition is developing, the leaf margins begin to curl and the leaf stands more erect than usual. The whole appearance of the stool suggests acute water shortage, although in reality, the soil may be extremely wet.

This condition is usually regarded as the direct consequence of froghopper attack, but such is not the case. As I have already mentioned, this state of affairs does not follow invariably upon even very severe froghopper attack and in some cases, a relatively slight primary blight may lead up to severe secondary browning of this nature. Moreover, the wilting does not spread from the original blight streaks, but begins from the tip and margins of the leaf. Such wilting also represents a different type of tissue injury, for if a leaf showing symptoms of this nature be held up to the light, the original blight streaks can be distinguished as opaque patches in a translucent surrounding.

When the roots of stools with wilted leaves are examined, the root system is readily seen to have become much reduced. Most of the deeper roots are completely dead and the fibrous roots, upon which the plant depends for the uptake of water and nutritive salts, are seriously depleted. This, of course, accounts for the similarity of the symptoms to those of drought.

Such a condition is brought about in the following way. In the normal cane stool, death of the older roots and their replacement by new ones is a normal process, just as is the death and replacement of old leaves. Defoliation is known by direct experiment to decrease the rate of root production or even to stop it altogether and in addition, to increase the rate at which old roots become inefficient. After froghopper blight then, which as we have seen, may destroy half or more of the effective leaf area, the cane is wholly or partly defoliated for all practical purposes, and the defoliation reacts upon the root condition.

If the soil conditions favour active root development, the check to growth is not excessively serious and, although the number of effective roots is reduced, enough are left to keep the plant growing. As the damaged leaves are replaced root development becomes normal once more, so that in the absence of further froghopper attack, the cane quickly resumes normal growth.

If soil conditions are poor, however, and the roots have been making but feeble growth even without the additional check of froghopper blight, it is easily seen that the extra hardship imposed by whole or partial defoliation is much more serious and froghopper attack may now put such canes into a critical condition.

Now the most severe froghopper attack, that due to second brood, takes place usually in late July or August, just after or during the wettest months of the year. At this time, the soil tends to be saturated with water; drains which may have been in first-class condition at the beginning of the rains are now probably badly choked or silted up and are certainly not working with their maximum efficiency. In addition, the fields may be very weedy owing to the diversion of labour from the estates to rice cultivation. All these conditions make for poor root development at the very time when, owing to the menace of froghopper attack, the most active root development is desirable.

To my mind, there is no doubt that quite a considerable acreage of cane in Trinidad, especially on the heavy clay soils, is on the verge of root atrophy in the wet season, even in the absence of froghopper. Any additional check to growth, not necessarily a severe froghopper attack, will in such cases produce the characteristic symptoms of acute root disease. Where, through enforced neglect of cultivation, these adverse conditions have become particularly marked, all the signs of root trouble become evident. This year, for example, there are plenty of fields attacked by root disease, which have entirely escaped froghopper attack, although the condition of the canes would suggest that they had been badly blighted. I do not mean to insinuate, of course, that there is anything particularly faulty with Trinidad planting methods; so far as my experience goes, I believe Trinidad methods compare very favourably with those in neighbouring colonies.

I have dealt with this aspect of the froghopper problem at some length because a proper understanding of it suggests the remedy. Experiments in former years have shown that, even after a field has been blighted, re-opening of the drains accelerates recovery from blight in a most remarkable way. It would be better, of course, not to wait until the canes are blighted before attending to this. When a large population of nymphs is seen in a field, steps should be taken immediately to see that drainage is as efficient as possible, so that active root development can be encouraged before the roots have become seriously reduced.

While drainage is one of the most important factors influencing root health, many other factors are also of importance. Other conditions being equal, deep cultivation makes for a stronger root system than shallow cultivation. This is well exemplified by a specific case, one of several which came under my notice in 1934 when, as you may remember, there was severe blight rather late in the year. The area in question was divided between two companies, the properties being separated only by an ordinary trace. The soil on both sides of the boundary was of the same type and a large area of cane on both sides was severely blighted, to about the same degree. On the land of one company, however, deep ploughing had been practised and, although the soil was a heavy clay, the tilth conditions in the first ratoons were still good. The adjoining estate did not practise deep ploughing. Three weeks after the adult froghoppers causing this attack of blight had passed away, cane stools were dug up from both properties, as near to the boundary as possible. The difference in the condition of the roots was most striking. Where the land had been ploughed deeply, the roots were still in excellent condition, showing a dense tangle of fibrous hairs. In the other case, fibrous hairs were almost completely absent; the main roots were dry and brittle and mostly dead or dying. The subsequent developments were also in keeping. On the first estate, recovery was rapid and complete, while on the other, the canes never recovered completely and the yield was only a fraction of the estimate.

In this connection, the selection of varieties for various types of soil is important. Probably this matter will become of even greater importance and offer more chance of avoiding froghopper losses by the selection of suitable varieties, when the new canes, now being produced and released from Barbados, become generally available. In the meantime, as might be expected, cane varieties with strong and active root systems can undergo blight when the growth conditions are poor and still suffer very little, when other varieties would be killed out by such conditions. Two varieties which suggest themselves at once are Uba and Co 213. The latter is a particularly good cane for many areas liable to froghopper attack, for not only has this variety the power to withstand considerable froghopper injury without undergoing critical root atrophy, but the cane is not readily attacked by froghoppers. This we know definitely from field experience and from critical plot experiment. Thus, when Co 213 and BH 10/12 are both available to froghoppers, it is found that Co 213 will have less than half as many blight streaks per leaf as the BH 10/12. Uba does not appear to be very markedly resistant

to froghopper attack, but its powers of recovery are well marked. Most planter are familiar with fields of BH 10/12 in which a few stools of Uba, or even a few beds of this variety, have been left. After a severe froghopper attack, the Uba is seen to be green and flourishing, when the BH is practically destroyed.

Provided that the drainage is adequate and that the season is not too far advanced, I believe that a small additional application of sulphate of ammonia to canes threatened with a big froghopper attack may be advantageous, and, by stimulating active vegetative growth at the time when this tends to slow down on account of froghopper damage, may in some degree minimise the destruction of roots. This matter, of course, urgently needs experimental test in the field. However if such extra manurial application is made, it should be done not later than the first appearance of froghopper adults. It is manifestly hopeless to attempt to stimulate cane growth in this way after the root system is destroyed.

I am fully convinced that we can still do a great deal towards preventing root complications following upon froghopper blight. Less frequently than formerly, certainly, but still too often, do we see cane beds flat on the top, or even with a central concavity, which makes adequate drainage impossible. In such cases, the central canes of the bed remain wilted long after the outer rows have recovered. Again, I have come across quite a number of beautifully cambered cane beds where the camber has been produced at the price of robbing the margins of the bed of all the top soil, with the result that the outer rows of cane are actually rooted in stiff clay subsoil. In such cases, while recovery may be excellent in the centre of the bed, the outer rows never regain their full vigour after a froghopper attack.

Even in the most obstinate cases of blight, complicated by root disease, there is usually a certain amount of recovery sooner or later, but this recovery too often sets in so late as to be of no commercial value. Recovery is dependant upon the formation of a new root system which arises, not from the old root bases, but from adventitious roots which grow down from the joints at or above the level of the soil. If the soil remains waterlogged, these roots, like their predecessors, are quickly killed on entering the soil and recovery is delayed until the new roots are able to gain a footing in soil in better condition. Such new root systems tend to be very superficial in character and they function less efficiently than deeper systems. It seems probable that the poor yields often obtained from fields which were blighted prior to the preceding crop may be attributable to this fact.

In addition to preventing root atrophy and to the consequent stimulation of recovery from blight, an attack upon the blight problem by the destruction of froghoppers naturally suggests itself. It is a fact that while root disease after blight is common, such disease would not occur in most cases if the canes had not been attacked by froghoppers. While the field conditions in blight-subject areas may not be the best possible, they are quite good enough to produce profitable yields if only they can escape froghopper attack. Furthermore, it is quite probable, as I have indicated, that uncomplicated froghopper damage itself takes an appreciable toll of the canes, so that destruction of the insects before they have blighted the canes would appear to be the most satisfactory procedure.

Froghopper eradication, however, is by no means an easy matter. Some estates appear to get a very good destruction of nymphs by the use of Cyanogas, but the method is admittedly expensive and, according to general experience in the colony as a whole, it is somewhat unreliable in the case of very heavy outbreaks. I should not like to attempt to dissuade anyone from using Cyanogas who is satisfied that the treatment pays, but I think that everyone will agree with me when I say that a more economical and efficient method of control is badly needed.

The only way of producing a hundred per cent. mortality of froghoppers which we yet know, is to plough up fields which are known to ha bour large quantities of eggs. The apparent immunity of plant canes from froghopper attack is due rather to the fact that fields for replanting are ploughed than to any special character of the canes themselves. It is possible to tell in the dry season which fields in an area are most likely to suffer severely from blight. The method consists of removing froghopper eggs mechanically from soil samples taken from he fields and counting them. We usually consider fields showing more than 800 eggs per stool as liable to severe infestation.

It would be possible, therefore, to reduce froghopper attacks very greatly by surveying the cane fields in this way during the dry season and ploughing all those which showed high egg populations. Such a survey, unfortunately, does not show the general level of severity of the coming attack, but only the fields which are most likely to be severely attacked, since the general level severity depends more upon climate than upon initial or potential insect populations. By rigidly following such a programme, there is a very real risk that a large and uneconomic amount of ploughing might be carried out in preparation for a season when froghopper attacks in any event would be slight.

Again, complete adherence to the indications of an egg survey would involve ploughing and re-planting many fields which in the ordinary way would be left to ratoon again. This would lead either to a greatly enlarged ploughing programme, with the loss of a year's crop from the ploughed fields, or to the retention of old ratoon fields which ought to be re-planted on general cultural grounds. Both these alternatives are very undesirable, of course. I believe none the less, that this method

may have a useful though limited application. It happens fairly often that a particular group of fields is blighted over most of its area year after year and it becomes desirable to clean up this area almost at any cost, in order to prevent such recurrent losses and to prevent a serious increase in the acreage affected. In such a case, the egg survey method is definitely of utility and will obviate the possibility of ploughing up fields unnecessarily.

The method of making the egg counts demands a high degree of skill and experience on the part of the workers and can hardly be done by the staff of an estate, particularly during the busy crop season. The Department of Agriculture however, is able to undertake this work, the estates obtaining and forwarding the samples for examination and I commend this matter to your serious consideration.

Before concluding, I should like to indicate briefly the lines which are now being followed in froghopper investigation. A study is being made in the first place of new insecticides and of methods of applying them. In recent years, great improvements have been made in spraying and dusting technique and it is now possible to apply oil sprays, for example, without the use of water, a method which means a considerable saving in expense. The most promising insecticides appear to be oil extracts of pyrethrum and pyrethrum dusts. These would be employed against adult froghoppers and applications could be made in most cases from the trace, without entering the field at all. It is hoped that a simple quantitative test of these methods may be made before the close of the present wet season.

Mr. Fennah of the Imperial College is, on my suggestion, making a study of several cane varieties in order to evaluate the relative resistance of each to froghopper attack. These results will be communicated to Barbados as they are obtained, where an attempt is being made to incorporate froghopper resistance with good milling properties in the breeding work.

BOILER SCALE.

THE following summary is taken from a report published in *Chemistry and Industry*, Vol. LV, No. 44, 1936, pp. 874-75, of a paper read by Mr. P. Hamer (Research Department, Messrs. Imperial Chemical Industries), before the Bristol Section of the Society of Chemical Industry. The paper was entitled "Boiler Feed Water Conditioning"; it mainly concerns recent advances in certain processes used for treating boiler feed water in order to prevent or diminish scale formation.

The *lime-soda process* for water-softening was first considered. In this process, the reagents cause the precipitation of lime as calcium carbonate, and of magnesia as magnesium hydroxide. The lime separates out readily, but the magnesia, being highly hydrated and flocculent, is deposited only slowly. In general, the settling of precipitates may be expedited either (1) by using a large excess of the reagents, (2) by heating the water to high temperature, (3) by adding a pre-formed precipitate in order to provide nuclei, and (4) by adding a coagulating agent. A satisfactory coagulant has been found in sodium aluminate; this substance, added in suitable amount, increases the efficiency of the lime-soda reagent by about 25 per cent.

The *mechanism of scale formation* in boilers was next described. The most common scale is calcium sulphate. Its prevention is based on the interaction between this substance in solution and added salts, such as sodium carbonate, sodium chloride, caustic soda and sodium sulphate. The effect of the additions in preventing calcium sulphate scale depends on the fact that substances whose solubilities increase with rising temperature (positive solubility coefficients) separate out of solution within the body of the boiler water, and thus do not form scale on the hot boiler surface. Calcium sulphate scale formation does not occur above a certain carbonate/sulphate ratio, but this ratio is affected by sodium salts (such as last three mentioned in the above list), all of which lower the ratio, especially sodium sulphate. In practice the use of a regulated amount of sodium carbonate added together with, say, sodium sulphate so as to adjust the carbonate/sulphate ratio, causes the formation of a thin soft scale of calcium carbonate instead of a thick impermeable hard scale of calcium sulphate.

Actually calcium sulphate scale, when not prevented, develops by crystallisation at points where bubbles of gas form on the metal surface, thus causing local superheating and the formation of a ring of tiny calcium sulphate crystals that subsequently act as nuclei for further crystallisation.

The most dangerous boiler scale is *silicate scale*, which is deposited from highly siliceous waters. This scale is thin, but does not conduct heat, so that boiler tubes in modern high pressure boilers may actually be ruptured when silicate scale forms on their surfaces. Whilst the exact mechanism of silicate scale formation is not yet understood, argument by analogy suggests that it may be similar to that deciding calcium sulphate scale formation. Silicate scale may be prevented in practice by adding sodium aluminate and magnesium sulphate in regulated quantities to the boiler feed water

The *adherence of scale-forming compounds* to metal surfaces presumably occurs primarily through the adsorption of ions, which may serve as nuclei for crystallisation. It has been found that the application of a potential of a few millivolts to a metal surface prevents ionic adsorption and adhesion of scale, but a larger potential appears to favour adhesion, possibly because it encourages the adsorption of ions of opposite charge. Such electrical methods of scale prevention are therefore somewhat difficult to apply in practice. The nature of the surface of the metal and of the adhering crystals must also exert a profound influence on scale adhesion. Thus, if the metal is coated with a layer of oxide, adhesion may be weakened or completely prevented.

THE CACAO INDUSTRY OF TRINIDAD.—*Continued.*

SOME ECONOMIC ASPECTS.

Series II.—A Financial Survey of Estates during the seven years 1923-4 to 1929-30.

By C. Y. Shephard.

PART III.—COMPARISON OF YEARLY RESULTS 1923-24 TO 1929-30.

(*See* Figs. VII-XII).

Prices and Yields (*See* Figs. IX and X).

During the period under review cacao prices varied more than yields, and proved the dominating factor in determining the profitableness of the different years. Thus, 1926-7 and 1927-8 were the most prosperous years principally because prices were at their highest level for the period, being $14.01 (£2 18*s.* 4½*d.*) and $14.18 (£2 19*s.* 1*d.*), respectively, per fanega, or $1.69 (7*s.* 0½*d.*) and $1.86 (7*s.* 9*d.*) respectively, above the average. These were the only two years in which the 'worst' estates operated at a profit. Yet, in 1926-7, the average yield of all the estates was the lowest recorded during the seven years, being only 231 lb. per acre, or 29 lb. below the average. On the other hand, yields in 1927-8 were the second best for the period, being 271 lb. per acre, or 11 lb. above the average.

The least profitable years were 1923-4 and 1929-30, when prices were at their lowest, being $10.02 (£2 1*s.* 9*d.*) and $10.48 (£2 3*s.* 8*d.*), respectively, per fanega, or $2.30 (9*s.* 7*d.*) and $1.84 (7*s.* 8*d.*), respectively, below the average. Yet, yields in 1923-4 were the highest for the period, being 277 lb. per acre, or 17 lb. above the average. On the other hand, yields in 1929-30 were the second lowest for the seven years, being 254 lb. per acre, or 6 lb. below the average.

Expenditure, Cost of Production, and Profits (*See* Figs. VII, VIII, X and XI).

During each of the seven years, the 'worst' estates were above, and the 'best' estates below, the average in total expenditure per acre, expenditure on cultivation per acre, and cost of production per bag. On the other hand, the 'best' estates were above, and the 'worst' estates below, the average in yields and profits. This supports the conclusion drawn from the average results of the seven years that the high yields and profits of the 'best' estates were not due to more intensive cultivation, nor the low yields and losses of the 'worst' estates to less ntensive cultivat ion.

Manuring.

Certain small but significant changes took place during this short period of seven years. From about 1927-8 the 'worst' estates began to take interest in the possibility of restoring yields by the application of artificial manures. They were discouraged, however, by the conflicting results, and very little progress had been made by the end of the period (1929-30). The best estates incurred no expenditure on the purchase of artificial manures.

Witchbroom Disease.

A small increase in the expenditure on specific measures for the control of diseases during 1929-30 marks the recognition of the serious menace presented by Witchbroom disease. From 1923-4 to 1928-29 the expenditure on all pests and diseases averaged 16 cents (8*d.*) per acre, but during 1929-30 it rose to 36 cents (1*s.* 6*d.*). Since 1929-30, the expenditure on Witchbroom has risen much higher, but low cacao prices and declining yields have prevented all but the most productive estates from keeping the disease under control.

Alternative Crops (*See* Fig. XII).

The loss of confidence in cacao, caused by the sudden break in prices in 1920, stimulated interest in the possibilities of other crops. From 1870 to 1920 high cacao prices encouraged planters to devote all suitable areas to that crop, and subsidiary crops were confined to land recognised as incapable of supporting cacao. Consequently, in 1923-4, the 'best' estates derived only two per cent. of their total income from crops other than cacao. The fact that the 'worst' estates relied upon subsidiary sources to the extent of 31 per cent. of their total income indicates that large sections were recognised as, or had proved, unsuitable for cacao. By 1929-30 the 'worst' estates had doubled their expenditure on alternative crops. Even the 'best' estates dallied for a time with new crops, but eventually came to the conclusion that cacao still offered the more attractive possibilities.

Summary.

A comparison of the records of individual years shows that prices varied more than yields and proved the principal factor in determining the general level of profits. Despite the fact that the 'worst' estates spent more per acre than the 'best' estates, especially on cultivation, they obtained lower yields, and incurred losses in five out of the seven years. This period heralds an awakening of interest in the commercial possibilities of artificial manures, and witnessed the appearance of Witchbroom disease. The 'best' estates continued to rely entirely upon cacao, but the 'worst' estates, in desperation, turned more and more to alternative crops.

PART IV.—COMPARISON OF THE PRINCIPAL CACAO GROWING DISTRICTS.

(*See* Tables II-V and Figs. XIII-XIX).

The development of the cacao industry of Trinidad proceeded, to a large extent, by districts, the more important of which are the Northern Range, Montserrat, Sangre Grande, Siparia, Talparo, Rio Claro and Moruga (*See* Fig. XIIIA). Some districts have acquired a high reputation, and others a poor one, as cacao producers, and in the present article their records are examined with the object of discovering the broad features associated with their comparative success or failure. In the larger districts, namely, the Northern Range, Montserrat and Sangre Grande, the estates are sub-divided into the 'best' and 'worst' groups.

Cost of Production and Profit per acre (*See* Figs. XV and XIX).

Moruga stands out as the district with the lowest cost of production per bag of cacao and the largest profits per acre. The Northern Range has the unenviable distinction of the highest costs of production and the smallest profits. Thus, it cost nearly twice as much to produce a bag of cacao in the Northern Range as in Moruga.

Cost of Production and Profits of the Principal Cacao Growing Districts.

District.	Cost of Production Per Bag of Cacao.					Profit per Acre.				
	Order.	$	£	s.	d.	Order.	$	£	s.	d.
Moruga ..	1	8.98	1	17	5	1	21.65	4	10	2½
Rio Claro	2	10.79	2	4	11½	2	14.69	3	1	2½
Talparo ..	3	11.05	2	6	0½	5	11.01	2	5	10½
Sangre Grande	4	11.49	2	7	10½	4	11.72	2	8	10
Montserrat	5	11.82	2	9	3	3	13.50	2	16	3
Siparia	6	13.69	2	17	0½	6	6.97	1	9	0½
Northern Range ..	7	17.02	3	10	11	7	1.88	0	7	10

This striking disparity in costs is due primarily to the fact that Moruga obtained yields twice as large as those in the Northern Range, namely, 374 lb. per acre (8.02 bags per 1,000 pickets), contrasted with 188 lb. per acre (4.17 bags per 1,000 pickets) (Fig. XVII). The high yields of the Moruga District cannot be attributed to intensive cultivation, nor can the low yields of the Northern Range be explained by neglect of cultivation. On the contrary, the Moruga estates spent less than any other district, except Talparo, on cultivation, while those in the Northern Range spent more than any other district except Montserrat. The actual expenditure on cultivation was $8.14 (£1 13*s.* 11*d.*) per acre in the Northern Range, and only $5.61 (£1 3*s.* 4½*d.*) in Moruga. The heavier expenditure of the Northern Range is common to every important item of cultivation (*See* Fig. XVI). Profits per acre in Moruga averaged more than 11 times those of the Northern Range. Despite high prices of cacao the Northern Range cleared a profit of only $1.88 (7*s.* 10*d.*) per acre, contrasted with $21.65 (£4 10*s.* 2½*d.*) in Moruga (*See* Fig. XIX).

Age of Cultivation.

The most striking difference between the Northern Range and Moruga Districts is the age of the cultivation. The valleys of the Northern Range and the banks of the river Caroni were the first areas in Trinidad to be established in cacao (9c). Moruga contains a few old estates, but the great majority of those examined were considerably below the average in age. It is possible, then, that certain factors associated with the age of the cultivation affect the yields, and thereby the profitableness, of estates. Support is lent to this suggestion by the fact that the Rio Claro District is second only to Moruga in youth of cultivation, cost of production per bag and profit per acre.

Differences in the age of cultivation, however, cannot be accepted as a complete explanation of the differences in yield between estates. The 'best' estates in the Montserrat District obtained an average yield of 494 lb. per acre (10.34 bags

per 1,000 pickets) at a cost of only $8.77 (£1 16s. 6½d.) per bag, and earned profits of $28.83 (£6 0s. 1½d.) per acre. These records are far superior to those of any similar group or district in the Island, despite the fact that the average age of the 'best' estates in the Montserrat district is far greater than that of the 'worst' estate in the same district and of the Moruga or Rio Claro estates. Differences in climatic conditions (*See* Fig. XIIIB) may account for part of the differences in yield between districts, but their range cannot explain the enormous variations in yield between estates within a single district, nor for the great contrast between some contiguous fields. Thus, within the Montserrat District, the 'worst' estates obtained less than half the yields of the 'best' estates, despite the fact that they spent $10.99 (£2 5s. 9½d.), compared with $7.14 (£1 9s. 9d.), per acre on cultivation. The 'worst' estates operated at a loss of 17 cents (8½d.) per acre, whereas the 'best' estates earned a profit of $28.83 (£6 0s. 1½d.) per acre. Moreover, some of the oldest fields in the Montserrat and Northern Range Districts rank amongst the most productive in Trinidad. The large differences in yield between contiguous fields of the same age, which have experienced similar cultural treatment and climatic conditions, appear to be due principally to variations in soil type. Factors associated with age may, however, play an important part in determining the trend of yields on individual fields.

Expenditure on Cultivation (*See* Fig. XVI).

An examination of the records of estates in the large districts of the Northern Range, Montserrat and Sangre Grande confirms the impression that the 'best' estates spend less, and the 'worst' estates more, than the average on cultivation. This statement also applies, with one exception, to each item of cultivation. In the Northern Range the 'best' estates spend more, and the 'worst' estates less, than the average on trimming and pruning the cacao trees. The great variation between districts in the amounts spent on particular operations is related to differences in natural conditions and the policies of owners. For example, on the low-lying heavy soils of the Sangre Grande District nearly twice the average amount is spent on draining. In the Talparo District expenditure on every item is below the average. An examination of the district expenditure on individual operations provides no clue as to their relative importance.

Subsidiary Crops.

It is significant that the least profitable cacao district, the Northern Range, spends most on subsidiary crops, derives the largest revenue from intercultivated crops, and is the only one to have experimented at all seriously with artificial manures. The Siparia District ranks next to the Northern Range in profitableness and in expenditure on subsidiary crops. In the three principal districts, the Northern Range, Sangre Grande and Montserrat, the 'best' estates spend considerably less than the 'worst' estates on subsidiary crops. The most profitable group, the 'best' estates in the Montserrat District, spent least of all on crops other than cacao, while the least profitable group, the 'worst' estates in the Northern Range, spent most on subsidiary crops.

Size of Estates.

The facts that the 'worst' estates in the Northern Range were far above, while the 'worst' estates in the Sangre Grande District were much below, the average in size, suggests that exceptionally large or small estates are less profitable than the average.

Summary.

The principal cacao growing districts of Trinidad exhibit great differences in yields, costs of production, and profit. The highest yielding districts spend less, and the lowest yielding districts more, than the average on cultivation. The youngest districts have the greatest yields and profits, and the oldest district the least yields and profits. The 'best' estates in the Montserrat District, however, obtained heavier yields and earned larger profits, than any other group or district in the Island, despite the fact that they were older than both the 'worst' estates in the same district, and the most profitable of the other districts. The 'best' estates in the larger districts spend less than the 'worst' estates on cultivation. The great variation in district expenditure on individual operations is determined by natural conditions and the policies of owners. The least profitable districts and groups of estates spend most, and the most profitable districts and groups of estates least, on subsidiary crops. Both exceptionally large and small estates appear to be less profitable than the average.

ERRATUM.

Fig. XV.—Montserrat, Cost of Production per Bag of Cacao on Worst Estates—*For* $8.83 *read* $18.83.

Table II.—Analysis of the Expenditure, Revenue, &c., of 20 Trinidad Cacao Estates in the **MONTSERRAT DISTRICT** for the Seven financial years, 1924-1930.

No.	Item. Description.	Expenditure per Acre of Cacao. Group of Estates. Best. $ c.	All. $ c.	Worst. $ c.	Cost per Bag (165 lb.) of Cacao. Group of Estates. Best. $ c.	All. $ c.	Worst. $ c.	Item No.
1	Management and Supervision ..	6.66	5.76	5.88	2.22	2.84	4.41	1
	Cultivation :							
2	"Supplying" Cacao Trees ..	.82	.92	1.33	.27	.45	1.00	2
3	Trimming and Pruning Trees..	1.84	2.02	2.63	.61	1.00	1.97	3
4	Cutlassing and Weeding ..	3.59	3.71	4.61	1.20	1.83	3.46	4
5	Draining and Roundridging ..	.51	.92	1.00	.17	.45	.75	5
6	Applying Manure	.24	.48	.87	.08	.24	.65	6
7	Pests and Diseases	.09	.12	.08	.03	.06	.06	7
8	Miscellaneous Cultivation ..	.05	.22	.47	.02	.11	.35	8
9	Total Cultivation ..	7.14	8.39	10.99	2.38	4.14	8.24	9
10	Reaping	4.05	3.48	3.56	1.35	1.72	2.67	10
11	Manufacture	1.36	1.02	.77	.46	.51	.58	11
12	Live Stock	2.03	1.56	1.30	.68	.77	.97	12
13	Buildings	1.48	1.05	.82	.49	.52	.61	13
14	Taxes	.55	.49	.33	.18	.24	.25	14
	Estate Supplies :							
15	Manures	..	..	..	..	..	..	15
16	Feed	.71	.50	.39	.24	.25	.29	16
17	Other	1.24	.80	.23	.41	.39	.17	17
18	Total Supplies	1.95	1.30	.62	.65	.64	.46	18
19	Miscellaneous	.16	.24	.16	.06	.12	.12	19
20	Roads and Bridges	.27	.35	.46	.09	.17	.34	20
22	Total Cost	25.65	23.64	24.89	8.56	11.67	18.65	22
23	Revenue from Inter-cultivated crops	.16	.19	.10	.05	.10	.07	23
24	Cost on Estate	25.49	23.45	24.79	8.51	11.57	18.58	24
25	Transport to Merchant's Store ..	.78	.50	.24	.26	.25	.18	25
26	Cost at Merchant's Store ..	26.27	23.95	25.03	8.77	11.82	18.76	26
29	Revenue from Cacao	55.10	37.45	24.86	18.39	18.49	18.63	29
30	Profit on Cacao	28.83	13.50	..	9.62	6.67	..	30
31	Loss on Cacao	..	..	.17	..	..	.13	31
32	Other Expenditure	.08	1.50	3.24	.02	.74	2.43	32
33	Other Revenue	.22	1.65	1.27	.07	.81	.95	33
34	Total Expenditure	26.35	25.45	28.27	8.79	12.56	21.19	34
35	Total Revenue	55.32	39.10	26.13	18.46	19.30	19.58	35
36	Profit	28.97	13.65	..	9.67	6.74	..	36
37	Loss	..	..	2.14	..	..	1.61	37
38	Interest Received	..	.01	.02	..	..	.01	38
39	Interest Paid	9.67	4.58	.60	3.23	2.26	.44	39
40	Net Profit	19.30	9.08	..	6.44	4.48	..	40
41	Net Loss	..	..	2.72	..	..	2.04	41
		Total.			Average.			
42	Cacao Acreage	1,394	4,930	1,320	279	247	264	42
43	No. of Cacao Pickets in 1,000's ..	404	1,453	380	81	73	76	43
44	Valuation in 1,000's $	440	1,226	240	88	61	48	44
45	Yield in bags of Cacao ..	4,177	9,987	1,761	835	499	352	45
46	Yield in bags per 1,000 pickets ..	..	..	..	10.34	6.87	4.64	46
47	Yield in lb. per acre	..	..	..	494	334	220	47
48	Yield in lb. per picket	..	..	..	1.71	1.13	.77	48
49	Price of cacao per fanega in $ ..	..	..	..	12.26	12.32	12.42	49
50	Per cent. return on capital ..	..	..	..	9.18	5.49	(loss)1.18	50
51	No. of estates surveyed ..	5	20	5	..	..	..	51

Table III.—Analysis of the Expenditure, Revenue, &c., of 23 Trinidad Cacao Estates in the **SANGRE GRANDE DISTRICT** for the seven Financial years, 1923-4 to 1929-30.

No.	Item. Description.	Expenditure per Acre of Cacao. Group of Estates. Best. $ c.	All. $ c.	Worst. $ c.	Cost per Bag (165 lb.) of Cacao. Group of Estates. Best. $ c.	All. $ c.	Worst. $ c.	Item No.
1	Management and Supervision ..	4.81	4.70	5.70	2.24	2.71	3.61	1
	Cultivation:							
2	"Supplying" Cacao Trees ..	.34	.47	.69	.16	.27	.43	2
3	Trimming and Pruning Trees..	1.74	1.97	2.83	.81	1.14	1.79	3
4	Cutlassing and Weeding ..	2.44	2.57	3.32	1.14	1.49	2.10	4
5	Draining and Roundridging ..	1.04	1.70	2.78	.49	.98	1.76	5
6	Applying Manure ..	.14	.21	.29	.06	.12	.19	6
7	Pests and Diseases ..	.20	.27	.35	.09	.16	.22	7
8	Miscellaneous Cultivation ..	.12	.11	.24	.06	.06	.15	8
9	Total Cultivation ..	6.02	7.30	10.50	2.81	4.22	6.64	9
10	Reaping	2.67	2.49	2.32	1.24	1.44	1.47	10
11	Manufacture	1 00	.88	.89	.47	.50	.56	11
12	Live Stock	1.27	.95	.66	.59	.55	.42	12
13	Buildings	.60	.81	1.03	.28	.47	.65	13
14	Taxes	.80	.67	.72	.37	.39	.45	14
	Estate Supplies:							
15	Manures	..	.03	.10	..	.02	.06	15
16	Feed	.53	.35	.35	.25	.20	.22	16
17	Other	.67	.56	.59	.31	.32	.38	17
18	Total Supplies	1.20	.94	1.04	.56	.54	.66	18
19	Miscellaneous	.17	.15	.19	.08	.09	.12	19
20	Roads and Bridges	.33	.50	.53	.15	.29	.33	20
22	Total Cost	18.87	19.39	23.58	8.79	11.20	14.91	22
23	Revenue from Inter-cultivated crops	.19	.20	.12	.09	.12	.07	23
24	Cost on Estate	18 68	19.19	23.46	8.70	11.08	14.84	24
25	Transport to Merchant's Store ..	.77	.71	.63	.36	.41	.40	25
26	Cost at Merchant's Store ..	19.45	19.90	24.09	9.06	11.49	15.24	26
29	Revenue from Cacao	38.91	31.62	29.46	18.13	18.26	18.63	29
30	Profit on Cacao	19.46	11.72	5.37	9.07	6.77	3.39	30
31	Loss on Cacao	..	..	..	..	..	..	31
32	Other Expenditure	.43	.91	.76	.20	.53	.48	32
33	Other Revenue	.40	1.35	1.78	.18	.78	1.13	33
34	Total Expenditure	19.88	20.81	24.85	9.26	12.02	15.72	34
35	Total Revenue	39.31	32.97	31.24	18.31	19.04	19.76	35
36	Profit	19.43	12.16	6.39	9.05	7.02	4.04	36
37	Loss	..	..	..	..	..	..	37
38	Interest Received	.02	.03	.10	.01	.02	.07	38
39	Interest Paid	3.18	2.35	1.70	1.48	1.36	1.08	39
40	Net Profit	16.27	9.84	4.79	7.58	5.68	3.03	40
41	Net Loss	..	..	..	..	..	..	41
		Total.			Average.			
42	Cacao Acreage	1,194	4,912	797	199	214	133	42
43	No. of Cacao Pickets in 1,000's ..	342	1,331	225	57	58	37	43
44	Valuation in 1,000's $	290	1,377	176	48	60	29	44
45	Yield in bags of Cacao ..	2,563	8,507	1,260	427	370	210	45
46	Yield in bags per 1,000 pickets ..	..	..	..	7.50	6.39	5.60	46
47	Yield in lb. per acre ..	..	..	..	354	286	261	47
48	Yield in lb. per picket ..	..	..	..	1.24	1.05	.92	48
49	Price of cacao per fanega in $ ..	..	..	..	12.09	12.17	12.42	49
50	Per cent. return on capital ..	..	..	..	7.99	4.34	2.89	50
51	No. of estates surveyed ..	6	23	6	..	..	..	51

Table IV.—Analysis of the Expenditure, Revenue, &c., of 37 Trinidad Cacao Estates in the **NORTHERN RANGE** for the seven financial years, 1923-4 to 1929-30.

No	Item. Description.	Expenditure per Acre of Cacao. Group of Estates. Best.	All.	Worst.	Cost per Bag (165 lb.) of Cacao. Group of Estates. Best.	All.	Worst.	Item No.
		$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	
1	Management and Supervision ..	4.98	4.47	3.50	3.02	3.91	3.94	1
	Cultivation:							
2	"Supplying" Cacao Trees ..	.49	.78	.87	.29	.68	98	2
3	Trimming and Pruning Trees..	2.39	2.01	1.77	1.45	1.76	1 99	3
4	Cutlassing and Weeding ..	2.80	3.70	4.53	1.70	3.24	5 10	4
5	Draining and Roundridging ..	.28	.74	1.44	.17	.65	1 62	5
6	Applying Manure	.83	.64	.74	.51	.56	.84	6
7	Pests and Diseases	.17	.15	.13	.10	.13	.14	7
8	Miscellaneous Cultivation ..	.07	.12	.07	.04	.10	.08	8
9	Total Cultivation ..	7.03	8.14	9.55	4.26	7.12	10.75	9
10	Reaping	2.98	2.05	1.40	1.81	1.80	1.58	10
11	Manufacture	1.21	.74	.46	.73	.65	.52	11
12	Live Stock	1.06	.91	.84	.64	.80	.95	12
13	Buildings	.92	.98	1.04	.56	.86	1.17	13
14	Taxes	.66	.61	.60	.40	.54	.67	14
	Estate Supplies:							
15	Manures	.04	.21	.52	.03	.18	.59	15
16	Feed	.80	.49	.53	.48	.43	.59	16
17	Other	.92	.80	.85	.56	.70	.96	17
18	Total Supplies	1.76	1.50	1.90	1.07	1.31	2.14	18
19	Miscellaneous	.02	.28	.32	.02	.25	.36	19
20	Roads and Bridges	.30	.33	.25	.18	.29	.29	20
22	Total Cost	20.92	20.01	19.86	12.69	17.53	22.37	22
23	Revenue from Inter-cultivated crops	2.20	.99	.54	1.33	.87	.61	23
24	Cost on Estate	18.72	19.02	19.32	11.36	16.66	21.76	24
25	Transport to Merchant's Store ..	.57	.41	.28	.34	.36	.32	25
26	Cost at Merchant's Store ..	19.29	19.43	19.60	11.70	17.02	22.08	26
29	Revenue from Cacao	31.33	21.31	17.39	19.00	18.66	19.59	29
30	Profit on Cacao	12.04	1.88	..	7.30	1.64	..	30
31	Loss on Cacao	..	..	2.21	..	..	2.49	31
32	Other Expenditure	.95	3.13	5.90	.57	2.74	6.65	32
33	Other Revenue	.74	3.08	6.28	.45	2.70	7.07	33
34	Total Expenditure	20.24	22.56	25.50	12.27	19.76	28.73	34
35	Total Revenue	32.07	24.39	23.67	19.45	21.36	26.66	35
36	Profit	11.83	1.83	..	7.18	1.60	..	36
37	Loss	..	..	1.83	..	..	2.07	37
38	Interest Received	.04	.02	.01	.03	.02	.01	38
39	Interest Paid	.40	.32	.43	.25	.28	.49	39
40	Net Profit	11.47	1.53	..	6.96	1.34	..	40
41	Net Loss	..	..	2.25	..	..	2.55	41
		Total.			Average.			
42	Cacao Acreage	1,694	10,269	3,930	188	278	437	42
43	No. of Cacao Pickets in 1,000's ..	489	2,813	1,108	54	76	123	43
44	Valuation in 1,000's $	420	1,778	533	47	48	59	44
45	Yield in bags of Cacao ..	2,793	11,727	3,488	310	317	388	45
46	Yield in bags per 1,000 pickets ..	..	..	..	5.71	4.17	3.15	46
47	Yield in lb. per acre	..	..	..	272	188	146	47
48	Yield in lb. per picket	..	..	..	.94	.69	.52	48
49	Price of cacao per fanega in $ ..	..	..	..	12.67	12.44	13.06	49
50	Per cent. return on capital ..	..	..	..	4.77	1.06	(loss)1.35	50
51	No. of estates surveyed ..	9	37	9	..	..	..	51

Table V.—Analysis of the Expenditure, Revenue, &c., of 37 Trinidad Cacao Estates in the districts of **SIPARIA, TALPARO, RIO CLARO AND MORUGA** for the seven financial years 1923-4 to 1929-30.

No.	Item. Description.	Expenditure per Acre of Cacao. District. Siparia. $ c.	Talparo. $ c.	Rio Claro. $ c.	Moruga. $ c.	Cost per Bag (165 lb.) of Cacao. District. Siparia. $ c.	Talparo. $ c.	Rio Claro. $ c.	Moruga. $ c.	Item No.
1	Management and Supervision	5.38	5.09	4.06	5.30	3.67	3.42	2.33	2.34	1
	Cultivation:									
2	"Supplying" Cacao Trees..	.74	.22	.67	.59	.50	.15	.39	.26	2
3	Trimming and Pruning Trees	1.40	1.32	1.78	1.43	.96	.88	1.02	.63	3
4	Cutlassing and Weeding ..	2.74	2.15	2.51	2.20	1.87	1.44	1.44	.97	4
5	Draining and Roundridging	.82	.44	1.06	.62	.56	.29	.61	.28	5
6	Applying Manure ..	.30	.10	.09	.16	.20	.07	.05	.07	6
7	Pests and Diseases ..	.46	.10	.05	.43	.31	.07	.03	.19	7
8	Miscellaneous Cultivation ..	.16	.18	.07	.18	.11	.13	.04	.08	8
9	Total Cultivation ..	6.62	4.51	6.23	5.61	4.51	3.03	3.58	2.48	9
10	Reaping	2.14	2.33	2.13	3.45	1.46	1.57	1.22	1.52	10
11	Manufacture	.72	.81	.87	1.23	.49	.54	.50	.54	11
12	Live Stock	1.13	.87	.67	1.29	.77	.58	.39	.57	12
13	Buildings	.90	.58	1.36	.85	.61	.39	.78	.37	13
14	Taxes	.81	.78	.54	.44	.55	.52	.31	.20	14
	Estate Supplies:									
15	Manures	.01	.01	..	..	.01	..	..	..	15
16	Feed	.33	.23	.45	.33	.23	.16	.26	.15	16
17	Other	1.10	.40	1.16	.52	.75	.27	.66	.23	17
18	Total Supplies ..	1.44	.64	1.61	.85	.99	.43	.92	.38	18
19	Miscellaneous	.34	.42	.33	.15	.23	.28	.19	.06	19
20	Roads and Bridges ..	.18	.13	.58	.35	.13	.09	.34	.16	20
22	Total Cost	19.66	16.16	18.38	19.52	13.41	10.85	10.56	8.62	22
23	Revenue from Inter-cultivated crops ..	.27	.14	.07	.20	.18	.09	.04	.09	23
24	Cost on Estate	19.39	16.02	18.31	19.32	13.23	10.76	10.52	8.53	24
25	Transport to Merchant's Store	.68	.44	.47	1.02	.46	.29	.27	.45	25
26	Cost at Merchant's Store ..	20.07	16.46	18.78	20.34	13.69	11.05	10.79	8.98	26
29	Revenue from Cacao ..	27.04	27.47	33.47	41.99	18.45	18.44	19.23	18.54	29
30	Profit on Cacao	6.97	11.01	14.69	21.65	4.76	7.39	8.44	9.56	30
31	Loss on Cacao	..	..	..	..	..	..	..	..	31
32	Other Expenditure ..	3.04	.86	.40	.99	2.07	.58	.23	.44	32
33	Other Revenue	5.30	1.40	.66	1.49	3.61	.94	.38	.66	33
34	Total Expenditure ..	23.11	17.32	19.18	21.33	15.76	11.63	11.02	9.42	34
35	Total Revenue	32.34	28.87	34.13	43.48	22.06	19.38	19.61	19.20	35
36	Profit	9.23	11.55	14.95	22.15	6.30	7.75	8.59	9.78	36
37	Loss	..	..	..	..	..	..	..	..	37
38	Interest Received	.04	..	..	..	.02	..	..	..	38
39	Interest Paid	.37	3.18	6.03	2.64	.25	2.13	3.46	1.16	39
40	Net Profit	8.90	8.37	8.92	19.51	6.07	5.62	5.13	8.62	40
41	Net Loss	..	..	..	..	..	..	..	..	41
		Total.				Average.				
42	Cacao Acreage	3,673	1,855	1,709	2,619	367	186	285	238	42
43	No. of Cacao Pickets in 1,000's	1,036	551	378	739	104	55	63	67	43
44	Valuation in 1000's $ ..	816	435	397	723	82	43	66	66	44
45	Yield in bags of Cacao ..	5,384	2,763	2,974	5,930	538	276	496	539	45
46	Yield in bags per 1,000 pickets	..	..	..	..	5.19	5.02	7.86	8.02	46
47	Yield in lb. per acre ..	..	..	..	..	242	246	287	374	47
48	Yield in lb. per picket ..	..	..	..	..	.86	.83	1.30	1.32	48
49	Price of Cacao per fanega in $	..	..	..	..	12.30	12.30	12.82	12.36	49
50	Per cent. return on capital ..	..	..	..	..	4.15	4.92	6.43	8.02	50
51	No. of estates surveyed ..	10	10	6	11	..	..	..	..	51

COMPARISON OF THE BEST, ALL, AND WORST TRINIDAD CACAO ESTATES, 1923-4 TO 1929-30

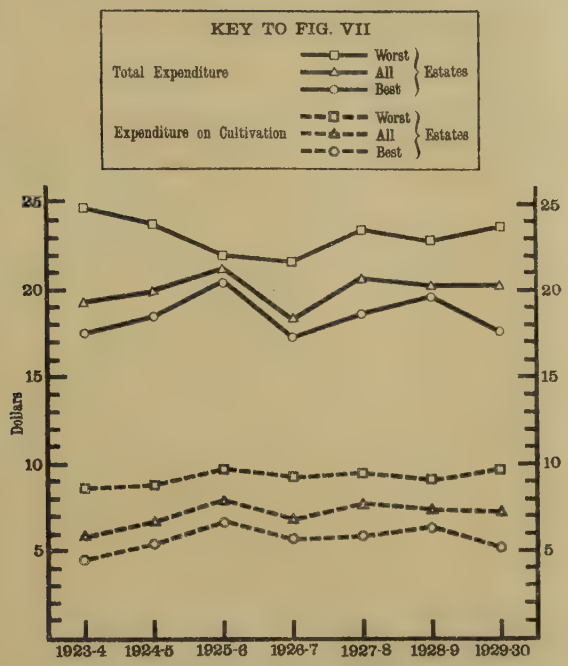

FIG. VII. TOTAL EXPENDITURE ON CACAO. & EXPENDITURE ON CULTIVATION ALONE, PER ACRE

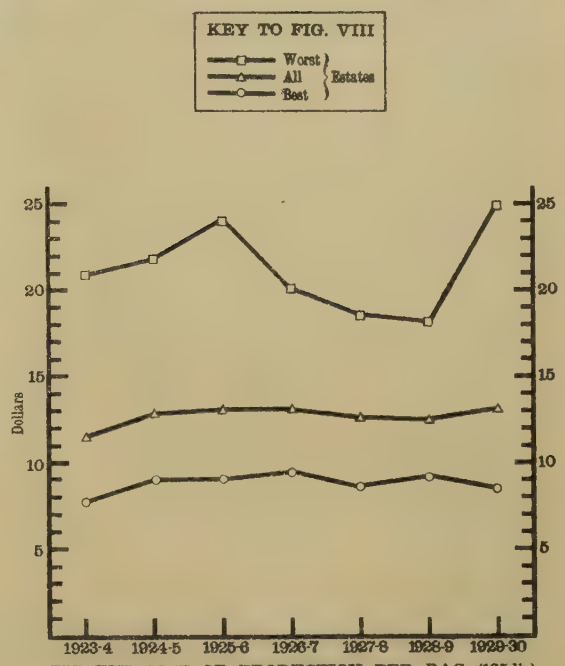

FIG. VIII. COST OF PRODUCTION PER BAG (165 lb.) OF CACAO

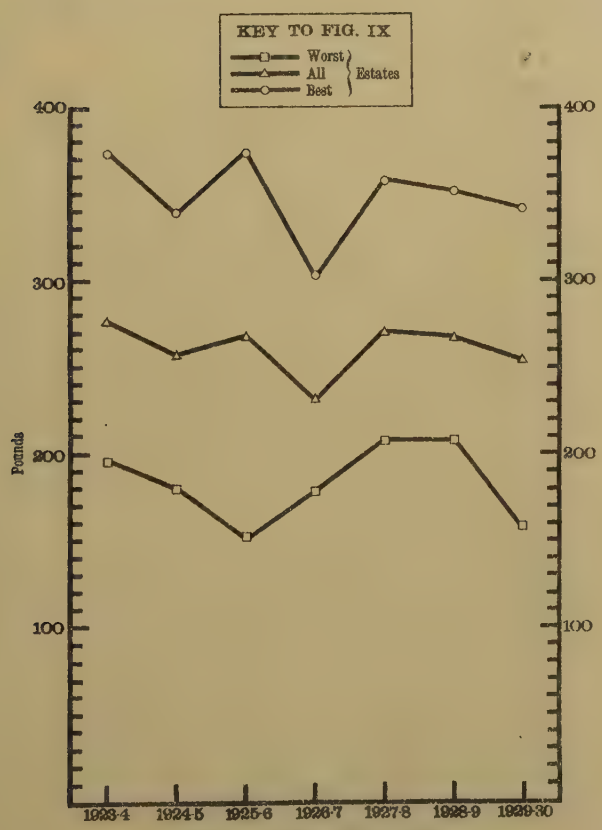

FIG. IX. YIELD PER ACRE.

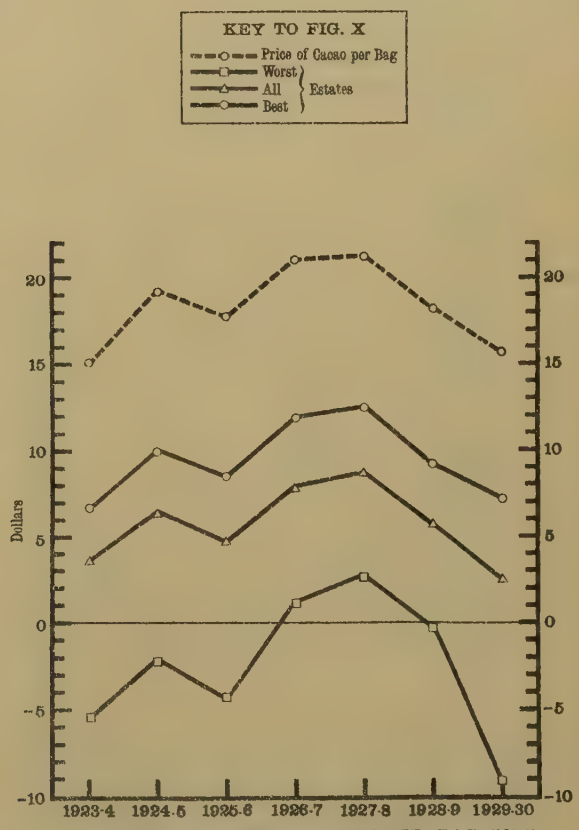

FIG. X. PRICE & PROFIT OR LOSS PER BAG (165 lb.) OF CACAO

COMPARISON OF THE BEST, ALL, AND WORST TRINIDAD CACAO ESTATES, 1923-4 TO 1929-30

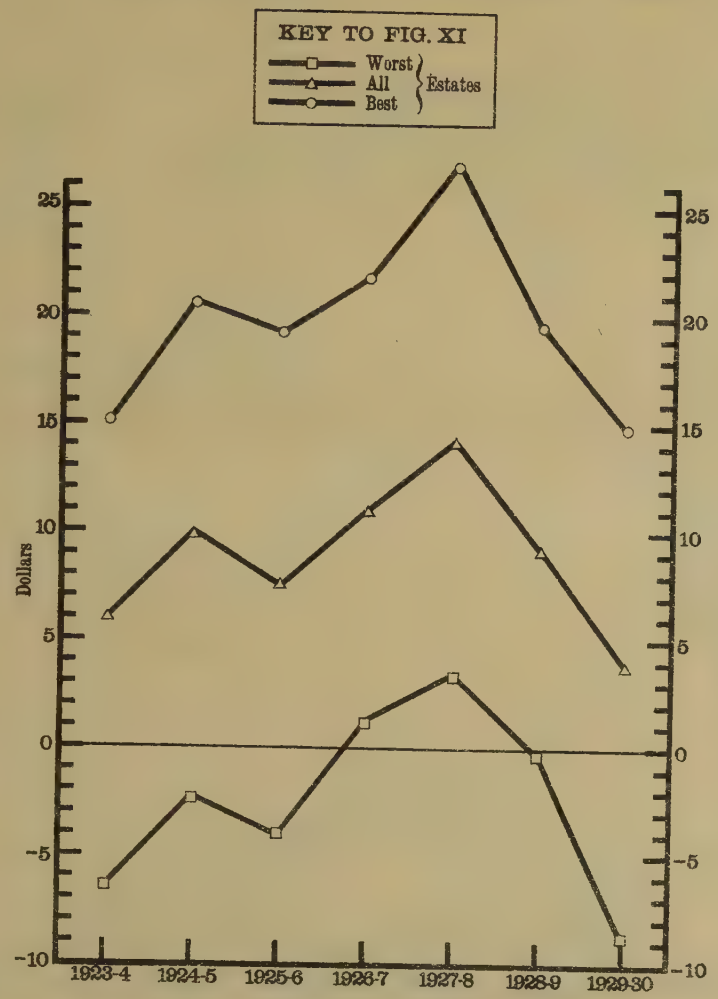

FIG. XI. PROFIT OR LOSS PER ACRE.

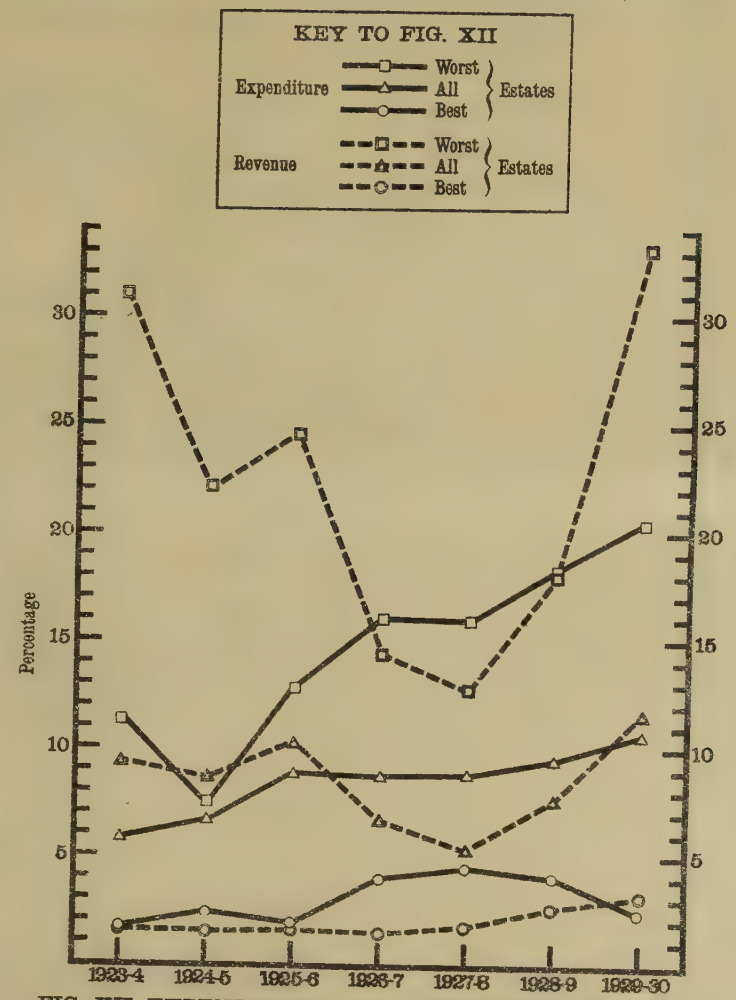

FIG. XII. EXPENDITURE ON & REVENUE FROM CROPS OTHER THAN CACAO EXPRESSED AS PERCENTAGES OF THE TOTAL EXPENDITURE & REVENUE

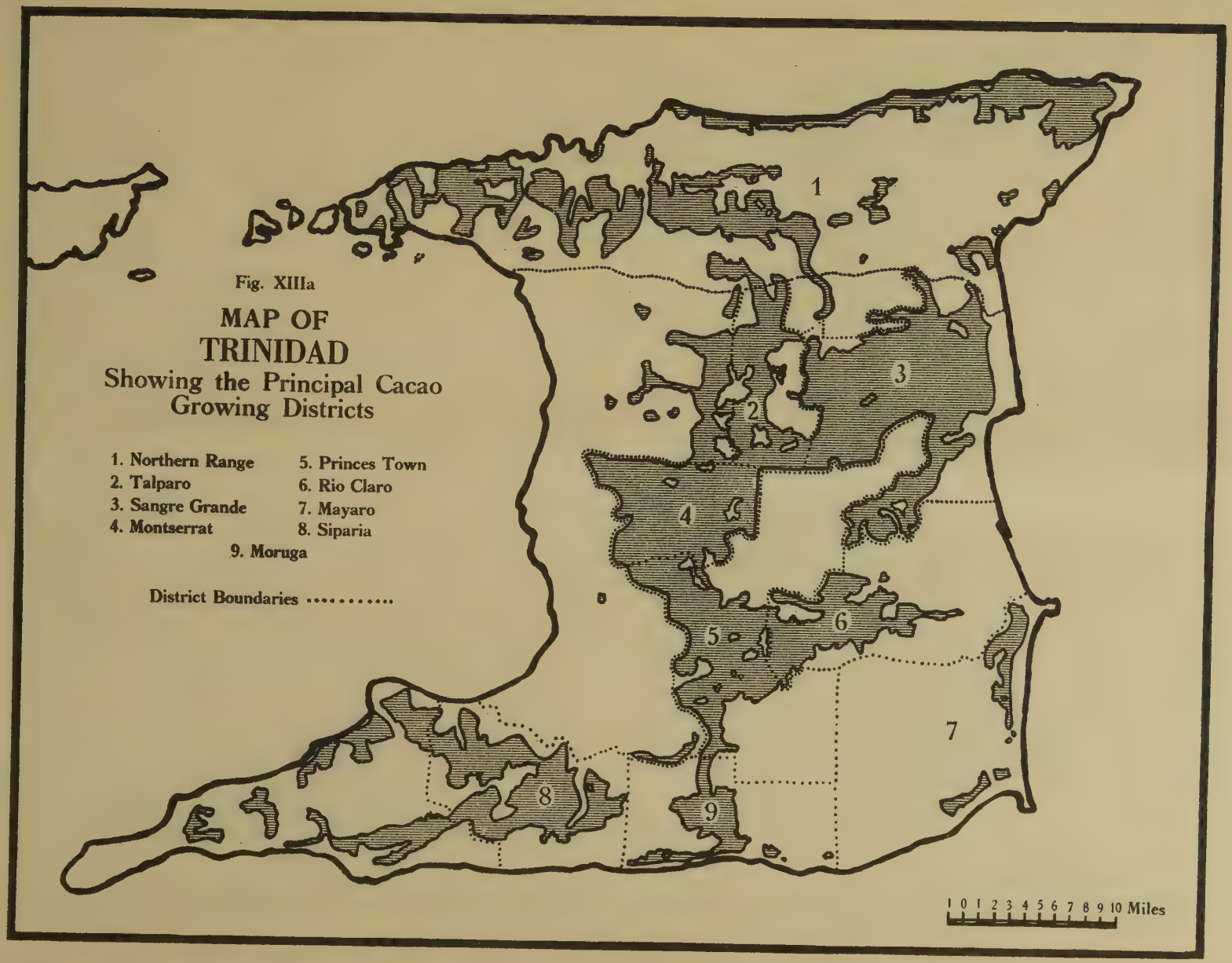
Fig. XIIIa
MAP OF
TRINIDAD
Showing the Principal Cacao
Growing Districts
1. Northern Range
2. Talparo
3. Sangre Grande
4. Montserrat
5. Princes Town
6. Rio Claro
7. Mayaro
8. Siparia
9. Moruga
District Boundaries .....
1
2
3
4
5
6
7
8
9
1 0 1 2 3 4 5 6 7 8 9 10 Miles

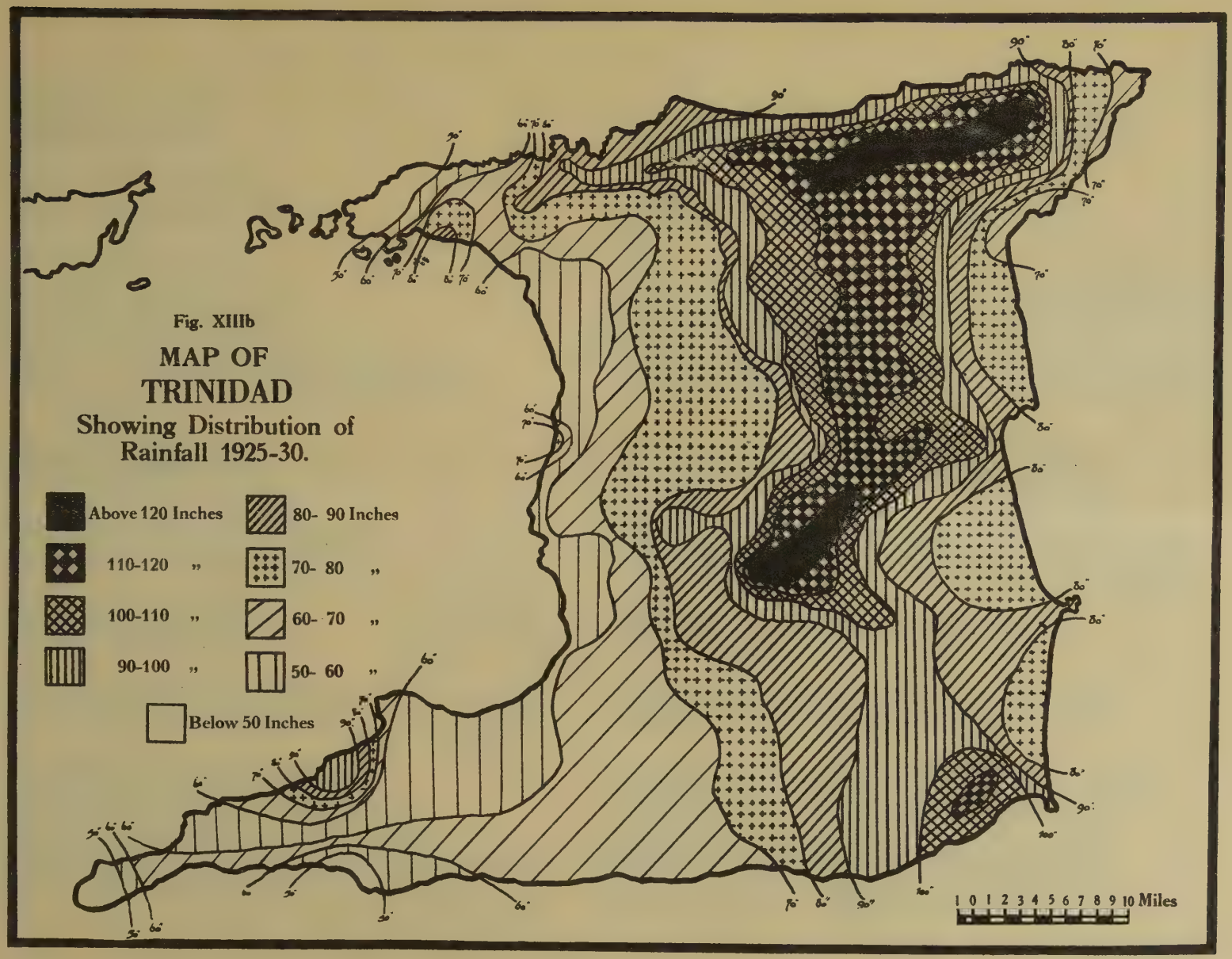
Fig. XIIIb
MAP OF
TRINIDAD
Showing Distribution of
Rainfall 1925-30.
Above 120 Inches
110-120 „
100-110 „
90-100 „
80- 90 Inches
70- 80 „
60- 70 „
50- 60 „
Below 50 Inches
1 0 1 2 3 4 5 6 7 8 9 10 Miles

COMPARISON OF THE PRINCIPAL CACAO GROWING DISTRICTS OF TRINIDAD, 1923-4 TO 1929-30

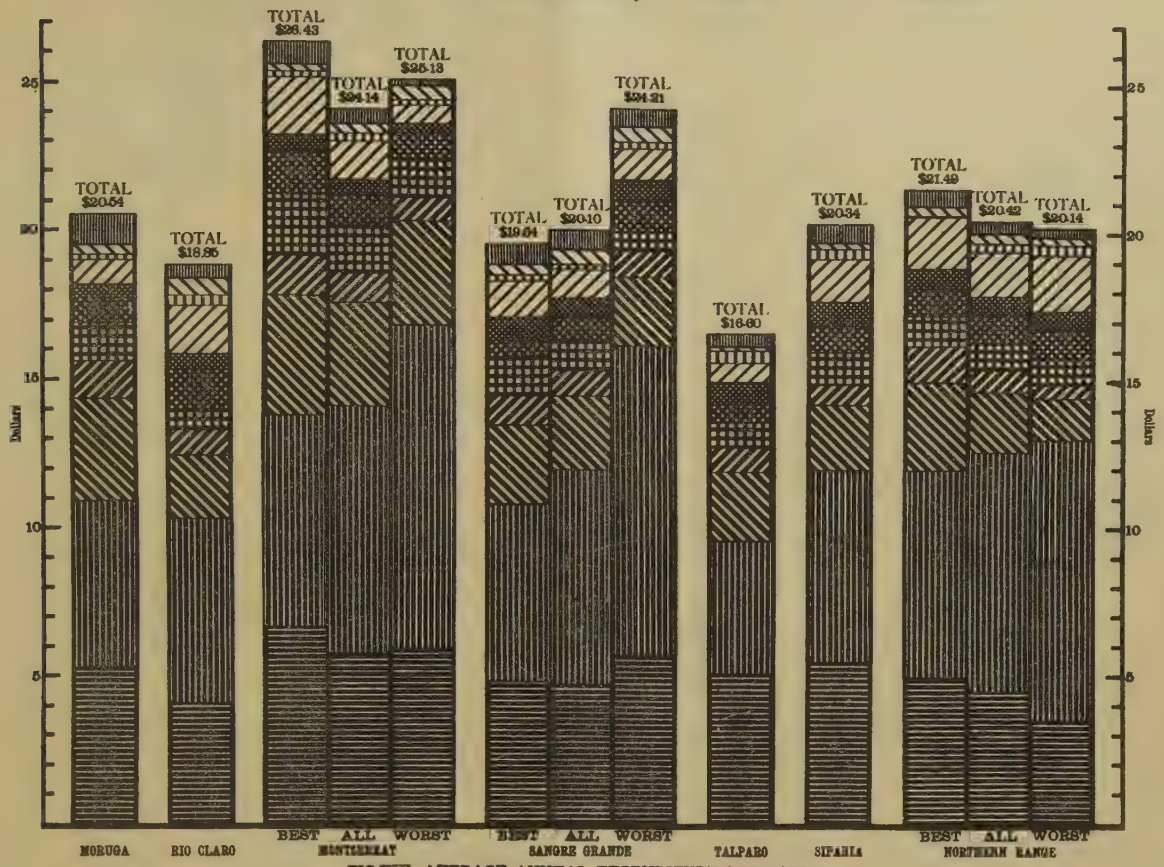

FIG.XIV. AVERAGE ANNUAL EXPENDITURE PER ACRE

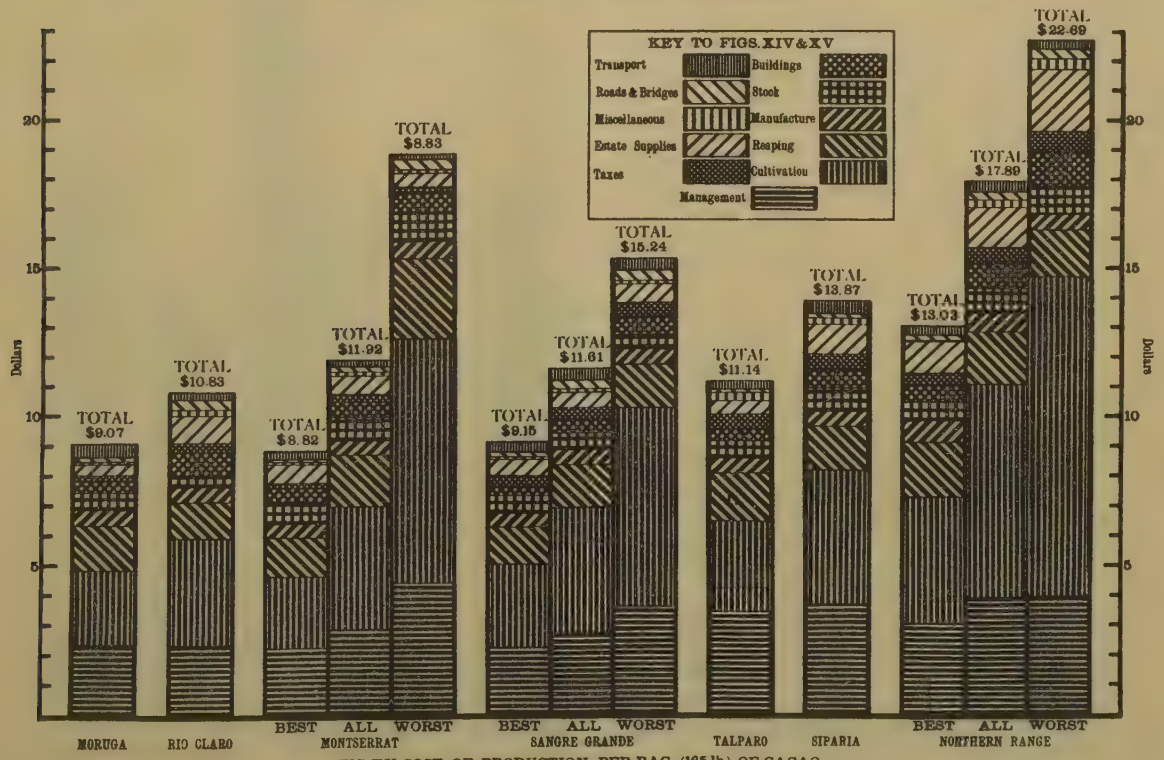

FIG.XV.COST OF PRODUCTION PER BAG (165 lb.) OF CACAO

COMPARISON OF THE PRINCIPAL CACAO GROWING DISTRICTS OF TRINIDAD, 1923-4 TO 1929-30

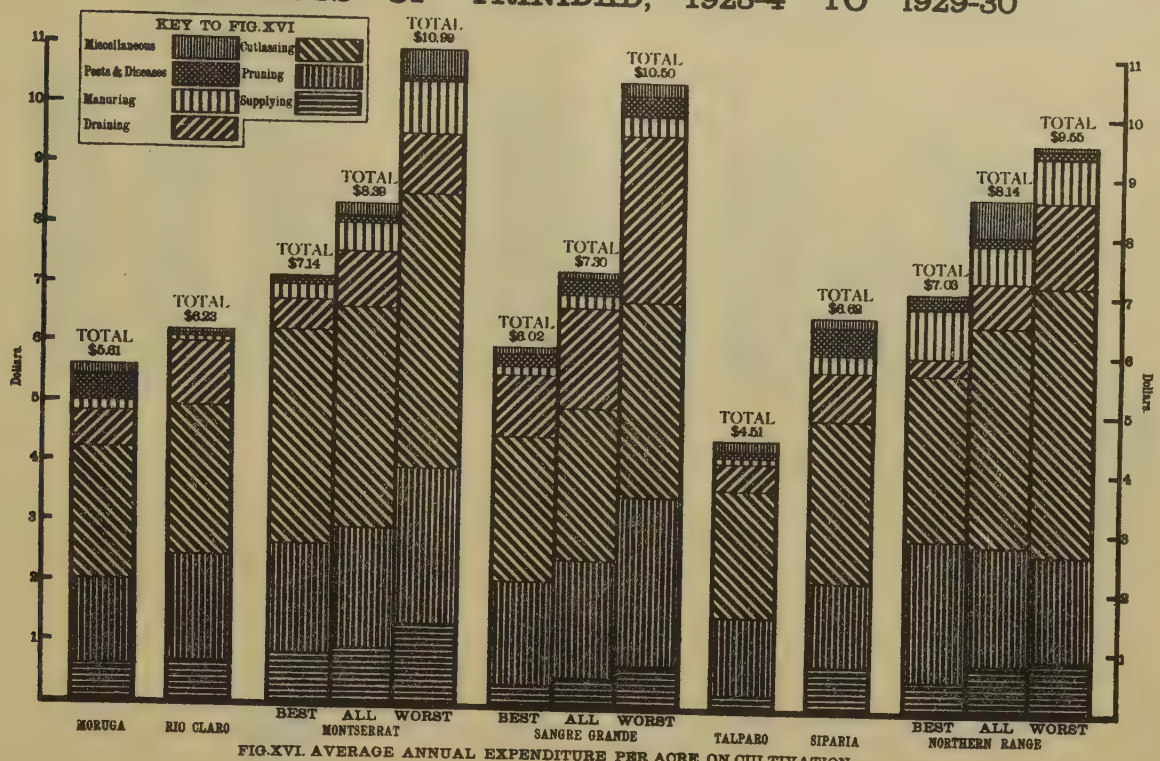

FIG. XVI. AVERAGE ANNUAL EXPENDITURE PER ACRE ON CULTIVATION

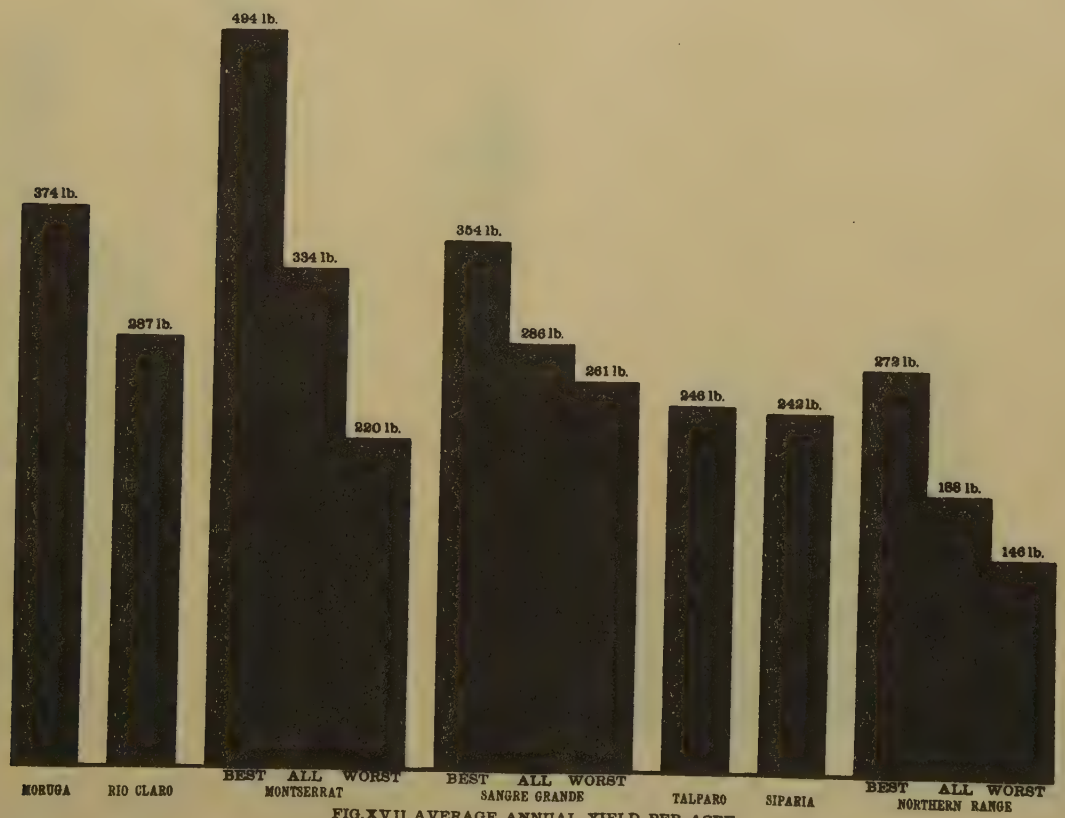

FIG. XVII. AVERAGE ANNUAL YIELD PER ACRE

COMPARISON OF THE PRINCIPAL CACAO GROWING DISTRICTS OF TRINIDAD, 1923-4 TO 1929-30

FIG. XVIII. PROFIT OR LOSS PER BAG (165 lb.) OF CACAO

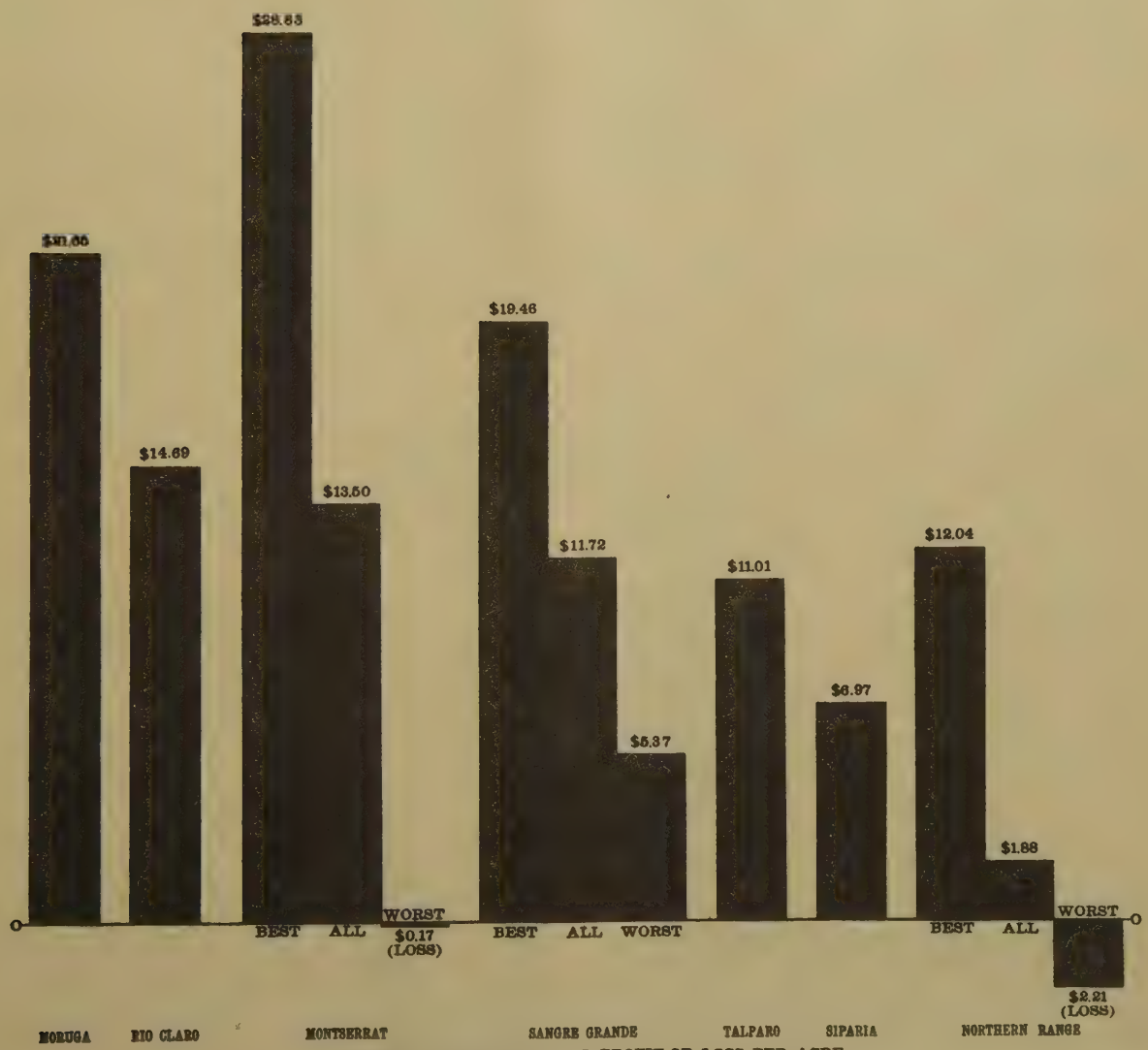

FIG. XIX. AVERAGE ANNUAL PROFIT OR LOSS PER ACRE

THE FRACTIONAL LIMING AND DOUBLE HEATING PROCESS.

During the past year, the Fractional Liming and Double Heating process has been evolved and successfully developed in the Department of Sugar Technology and the College Sugar Factory. A full description of the process has already appeared (1). The following summary outlines its main features in comparison with other established clarification processes for raw sugar production.

The advent of certain of the new varieties of cane has brought in its train a series of difficulties in the clarification of their juices. Notable amongst these varieties, in Trinidad, is POJ 2878. Other countries have recorded similar experiences. These difficulties can to some extent be alleviated by such procedures as (1) Sulphitation; (2) Liming to pH 9.0-10.0, and adding phosphate to adjust the reaction to pH 7.5. Heat. Settle; (3) Heat. Lime the hot juice to pH 7.8. Settle; or (4) Lime to pH 6.6. Heat. Lime to pH 7.6. Settle. Each will produce a clarified juice of the desired reaction, but with the processes not involving the use of sulphitation the objections found were high mud volumes, low clarity or slow settling. The Fractional Liming and Double Heating process (F.L. and D.H.) consists of liming to pH 6.4, heating to 212°F, liming to pH 7.6, heating to 212°F and settling. In comparing this with the standard Cold Liming process (C.L.) on the same lot of juice in four trials at the College Sugar Factory, the following results were obtained.

Table I.

B.H. 10(12) Juice only.

	Raw Juice.	Clarified Juice.	
		C.L.	F.L. and D.H.
Brix	15.60	16.20	16.50
Polarization	13.42	14.22	14.61
Sucrose %	13.47	14.28	14.64
Apparent Purity	86.01	87.77	88.54
Gravity Purity	86.34	88.14	88.72
pH	5.27	7.03	6.99
Muds %	—	10.70	5.00
Dye Value	689	469	445
P_2O_5 gms./100 ml.	0.0150	—	—
Ash % Brix	1.1790	1.0450	1.0870
Ether Extract % Brix	0.4160	0.0540	0.1000
Total Nitrogen % Brix	0.0183	0.1140	0.1040
Cryst. Nitrogen % Brix	0.0980	0.0980	0.0980
Colloid Nitrogen % Brix	0.0850	0.0160	0.0060
Pentosan % Brix	0.1472	0.0679	0.0586

(1) *I.S.J.* (1936) 38, pp. 298-300.

Table II.

P.O.J. 2878 Juice only.

	Raw Juice.	Clarified Juice.	
		C.L.	F.L. and D.H.
Brix	16.35	17.25	16.15
Polarization	12.18	12.88	12.31
Sucrose %	12.28	12.98	12.43
Apparent Purity	74.49	74.66	76.22
Gravity Purity	75.10	75.24	76.96
pH	5.06	7.08	7.10
Muds %	—	15.80*	10.70
Dye Value	619	513	487
P_2O_5 gms./100 ml.	0.0320	—	—
Ash % Brix	1.4980	1.5200	1.5340
Ether Extract % Brix	0.2884	0.0821	0.0085
Total Nitrogen % Brix	0.2260	0.1680	0.1330
Cryst. Nitrogen % Brix	0.1140	0.1140	0.1140
Colloid Nitrogen % Brix.	0.1120	0.0540	0.0190
Pentosan % Brix	0.1250	0.0934	0.0168

BH 10(12) was used as a non-refractory juice and POJ 2878 as a refractory juice. In comparing these results, the following becomes apparent:—

Table III.

	C.L. Process.		F.L. and D.H. Process.	
	B.H. 10(12)	P.O.J. 2878.	B.H. 10(12).	P.O.J. 2878.
Grav. Pur. rise; raw to clarified juice	1.80	0.14	2.38	1.86
Colloid (Dye Value) elimination %	32	18	36	22
Colloid Nitrogen elimination %	83	54	94	84
Pentosan elimination %	51	31	65	56
Ether extracts (fats, waxes, &c.) elimination %	87	72	76	97
Mud Volume %	10.7	15.8*	5.0	10.7

* This figure is for the Cold Liming process of one trial only. The juice in the other Cold Liming process trial showed no indications of settling after 2½ hours and was recorded as 100 per cent. muds. It was therefore not included in the above table.

Measurements of the total lime consumed with each process are outlined as follows :—

Table IV.

	(1) C.L.	(2) F.L. and D.H.	(1)—(2) % (1)
B.H. 10(12)	0.351	0.248	29.3
P.O.J. 2878	0.884	0.516	41.6
B.H. 10(12)	0.578	0.358	38.1
P.O.J. 2878	0.660	0.413	37.4
	Mean	Saving	36.6%

The special features of this process may be summarised as :—

(1) Rapid settling of refractory juices.
(2) Increased purity rise.
(3) Decreased lime consumption.
(4) Decreased mud volumes.

The alterations required in a factory at present using the cold liming process consist of the installation of a liming device at the mixed juice mill gutter, arranging the heaters to discharge into the present liming tanks and the addition of a low capacity heater (180°F to 212°F).

The process has already proved successful in a commercial factory in the West Indies.

J. G. D.

LEMONGRASS CULTIVATION AND DISTILLATION.*

THE lemongrass oil of commerce is derived from two species of grass, viz. : *Cymbopogon flexuosus* the Malabar or Cochin lemongrass, which is found in the Tinnevelli district and in Travancore of Southern India, and *Cymbopogon citratus*, which occurs in most tropical countries, especially in Ceylon, Burma, Java, Mauritius and the Malay Peninsula.

Lemongrass flourishes under subtropical and tropical conditions, preferably at low altitudes where the rainfall is fairly uniformly distributed throughout the year and the humidity of the atmosphere is high.

As regards soil conditions lemongrass is not very exacting, but makes more rapid growth on good well-drained soil, such as sandy loam. Lemongrass, however, is cultivated in Ceylon and in Madagascar on poor soils and under fairly dry conditions. In such cases, although it is stated that the oil is of a better quality, the yield is decidedly less ; furthermore, it is not possible, owing to the slower growth to cut the grass as frequently as that grown under better conditions.

Propagation of the plant is effected by division of the clumps. The portions separated, after shortening the leaves to about three inches, are set out in rows about three feet apart and at a distance of 1½ feet in the rows. The spacing varies to some degree according to the nature of the soil, on rich soils the distance usually allowed being greater than on poor ones.

Prior to planting, the land should have been ploughed over and broken up to a fairly fine tilth. In some countries it is customary before planting to dig in a dressing of fertiliser, or a leguminous crop. Planting should take place in the early spring or at the beginning of the rainy season at a time when the soil is sufficiently moist not to require artificial watering.

During early growth the ground should be frequently hoed to check weeds and to conserve soil moisture. Besides having a retarding action on the growth of the plant, weeds introduced into the still with the cut lemongrass often result in an undesirable odour in the oil.

After the first year only slight cultivation is needed, since after it is well established lemongrass tends to retard weed growth.

Although lemongrass is not normally manured during growth, it has been advocated that a dressing of fertiliser, as soon as the plants have become well established in the field, is beneficial to the plant. An economical fertiliser is said to be one containing four per cent. nitrogen, five per cent. potash and eight per cent. phosphoric acid, applied at the rate of 600 lb. per acre. This should be given as a side application and well worked in at the first cultivation.

The cutting of the grass may take place from four to nine months after planting, depending on the climatic and soil conditions of the locality. The height of the grass when ready for gathering is about 2½ to three feet. The grass is cut by hand, using a sickle, about nine inches above the ground-level. The number of cuttings varies from three to as many as seven gatherings per annum, according to the locality. The largest number of cuttings generally occurs in the second year of growth of the plant, when it is in full vigour. After this there is a falling-off in the rate of growth of the clumps and a decrease in the oil content of the leaves and after three or four years it is found necessary to replant the area.

The yield of fresh grass per cutting is approximately from four to five tons per acre. Allowing for an oil content of 0.2 per cent. in the green material this yield is equivalent to 16 to 20 lb. of oil per acre. The oil content is, however, often higher than this, sometimes reaching as much as 0.5 per cent.

Regarding the immediate treatment of the grass after cutting there appears to be some difference in opinion. Experiments in Malaya showed that by semi-drying the grass and hence saving labour in removing it to the still, there was no decrease in the quality or yield of the oil. It was, therefore, recommended that after cutting, the lemongrass should be spread out and allowed to dry for a few days, the loss in weight after four to five days being as much as 60 to 65 per

* (*Bulletin of the Imperial Institute*, Vol. XXXIV, No. 1, pp. 63-65, 1936).

cent. If the grass was piled, heating and fermentation ensued affecting both the yield and quality of the oil. On the other hand, experiments in the United States showed a considerable loss of oil on drying, although there was no effect on the citral content of the oil. It is usual in many of the countries where the grass is grown commercially to distil the fresh material as soon as possible after gathering.

The oil is recovered from the grass by the process of steam distillation. Up-to-date plant for this purpose consists essentially of three parts: (*a*) a boiler for raising steam; (*b*) a still in which the grass is packed; and (*c*) a condenser in which the mixed vapours of steam and oil are condensed. In view of the quantity of water required for the condenser the site of the still should be close to a regular water supply. The still, which should be made either of copper or iron (preferably enamel lined), is packed fairly full and steam passed in. The time taken for the distillation of one charge of grass should not be longer than four hours.

The mixture of condensed oil and steam is separated as far as possible in a separating funnel or other suitable apparatus. The oil should be stored in well-filled air tight containers in as cold a place as possible until ready for shipment. For transport the oil can be packed in tins or tin-lined iron drums without injury.

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MYCOLOGICAL NOTE.

*Studies on the Infection of Citrus Fruits.

1. *Some Methods of Infection by the Green Mould, Penicillium digitatum* Sacc., by G. R. Bates.

Green mould, *Penicillium digitatum*, Sacc. is of world-wide distribution and probably causes more wastage amongst export Citrus fruit than any other one fungus. Until recently it was thought that wounds or injuries of some description were essential for infection by green mould, but it has now been shown that under certain conditions infection of oranges is possible without previous wounding, and also that certain types of wounds do not usually cause infection.

The writer in South Africa has shown that dry spore inoculations of *P. digitatum* introduced by needle punctures between the oil vesicles up to a depth of 1.5-2 mm. do not cause infection. On the other hand, without exception, every orange, lemon and grapefruit in the series of inoculations into oil vesicles showed rapid infection by *P. digitatum.* The resistance of all rind tissues to infection is not impaired by storage; oranges stored for 3 weeks at 40°F. and for a further nine weeks under atmospheric conditions were still resistant to dry spore inoculations 1.5 mm. in depth between the oil vesicles, while similar inoculations into the oil vesicles caused 100 per cent. infection. It was found, however, that inoculation of wounds between oil vesicles was successful if a spore suspension in distilled water was used, and also that the minute punctures made by scale insects were sufficient to allow of infection. Under certain conditions therefore, scale-infested oranges are potentially more liable to infection by *P. digitatum* than sound oranges, and the danger of infection is not in the least reduced by removing the scale.

In the packing house it was shown that a very considerable amount of infection of fruit takes place as it passes the polishing brushes. Oranges in which six oil vesicles each had been wounded to a depth of 2.0 mms. were passed through the brushes in the middle of the day's run of fruit. After 35 days 39 per cent. were infected with *P. digitatum.* Wilting or drying of damaged oranges even for several days has little or no effect upon their subsequent liability to infection.

This paper shows how important is the careful handling of citrus fruit both in picking and packing if serious losses from fruit rot due to *P. digitatum* are to be avoided. Since infection is possible through one ruptured oil gland, methods of handling citrus fruit must be such that these delicate structures remain undamaged.

R. E. D. B.

* British South Africa Company: *Mazoe Citrus Exp. Station Pub. No. 4b.* 1936.

THE EDITOR requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

CHEMICAL ELIXIRS OF LIFE.

Under this title, Dr. I. M. Heilbron, Professor of Organic Chemistry at the University of Manchester, England, in a Jubilee Memorial Lecture, described the recent advances in the chemistry of the sterols and related compounds. The following brief account is taken from his paper in the *Journal of the Society of Chemical Industry*, Vol. LV, No. 20, pp. 130T to 136T, 1936.

The sterols are higher alcohols which occur widely distributed in plant and animal tissues, either free or in combination with fatty acids. The most fully investigated sterol is cholesterol, typical of all higher animals. This has been known as a chemical individual for over 100 years, but it is only recently that its exact structural constitution has been elucidated. The sterol molecule contains a 4-carbon-ring system, and this tetracyclic arrangement is typical, not only of the sterols, but also of bile acids and of certain recently discovered sex hormones, which indicates its great significance as a structural chemical unit.

The most widely distributed plant sterol is sitosterol, which is similar in essential chemical constitution to cholesterol, but differs from it in the constitution of the side chains of the complex molecule. Another higher plant sterol is stigmasterol, present in soya bean. The marine brown algae contain a typical sterol called fucosterol, and moulds and yeasts also contain an important sterol, known as ergosterol.

Ergosterol is peculiar and important in that it can easily be converted into an *antirachitic vitamin* by irradiation with ultraviolet light. The photo-chemical changes that govern the conversion of ergosterol into the calcifying vitamin D are very complex, various substances being formed during the irradiation process. The isolation of a crystalline antirachitic product from irradiated ergosterol was first achieved in 1932 in London by a group of workers at the National Institute for Medical Research, and almost simultaneously by Windhaus and his collaborators in Germany. The new substance, to which the name *calciferol* was given, is not identical with ergosterol, however, since it contains a tricyclic and not a tetracyclic system of carbon atoms.

Until a few years ago, it had generally been assumed that ergosterol is the invariable and only precursor of the antirachitic vitamin D, but accumulating biological evidence has indicated that the vitamin D factor of cod-liver oil is *not* identical with artificially-prepared calciferol. Thus, cod-liver oil (which contains ergosterol) administered to chicks or children has proved to be 25 to 100 times as potent as calciferol in preventing rickets. Furthermore, crystallised irradiated cholesterol produces an antirachitic substance much more potent than an equivalent dose of irradiated ergosterol. A sterol may evidently be converted by means of irradiation into an antirachitic substance, provided it has a similar chemical constitution to ergosterol. Dr. Heilbron is at present attempting to isolate "active" sterols, such as ergosterol, from natural products. Wide variation was found for the sterols occurring in animal materials; for example, halibut liver-oil, 0.10 per cent.; egg-yolk, 0.20 per cent. and blood, 0.25 per cent., whilst the sterols of grasses contain between 1.0 and 1.5 per cent. of "active" sterol. The sterol of the sea anemone contains as much as 5.0 per cent. of the "active" form.

During the past two years, it has been demonstrated that the sex hormones have similar fundamental chemical constitution to the sterols. The characteristic constitutional formulae have been established and proved to be of the sterol type in the cases of oestrone and oestriol, occurring in the urine of pregnant women, and responsible for inducing the oestrous cycle, as well as influencing the development of secondary female characters. Another sex hormone, luteosterone, has recently been obtained from the corpus luteum, and has been shown to belong also to the sterol type of chemical substances. This hormone has actually been prepared from stigmasterol which is the sterol of soya beans. Finally, a hormone which controls the secondary sexual characters of the male has been isolated from male urine, and has been named androsterone. It also possesses the typical sterol constitution.

During the past decade, the developments in the chemistry of sterols has been monumental; the detailed structure of many of the sterols has been unravelled, and their relationships to the bile acids, the antirachitic vitamin D, and the sex hormones have been demonstrated. Partial chemical syntheses of these "elixirs of life" have rendered them available in quantity for use in precise biological investigations. In due course most of the remaining members of the hormone group will doubtless be prepared in the laboratory. Already this chapter of pure chemical achievement is playing its part in curative medicine, and contributing to the well-being of the human race.

A SIMPLE TEST FOR SEED VIABILITY.

Dr. Kozo Hasegawa, of the Forest Experimental Station, Imperial Household, Asakawa near Tokyo, claims to have had very reliable results in seed testing, with a colour reaction with a one per cent. solution of sodium tellurate (*Japanese J. Bot.*, 8 No. 1, 1936). A darkening of the living embryonic tissues takes place within 48 hours (at 16°C.) and this colour change then remains constant. It is claimed that the depth and extent of the colour change can be correlated with the vitality of the embryo. The author further states that no damage is done to the vitality of the embryo by this treatment. This simple method of testing viability will undoubtedly be given a trial in many laboratories where seed viability is a problem of first importance.—(*Nature*, Vol. CXXXVII, No. 3469, p. 710, 1936.)

WEST INDIAN NOTES.

(*Compiled by the Advisory Department, Imperial College of Tropical Agriculture.*)

The Sugar Industry.

Sugar crop prospects in St. Kitts and Antigua are very favourable. In the former rainfall has been ample and fairly well distributed and a record crop of about 33,000 tons is estimated. In Antigua the rains began as early as April and the year has been an unusually wet one. The sugar-cane crop has responded well and is expected to exceed 27,000 tons. Preparation for the 1936 planting is however very backward owing to the continuous rains.

The sugar industry in St. Lucia continues to expand slowly and the 1937 crop is estimated at 8,500 tons. In Barbados weather conditions throughout the season have not been so consistently favourable as in the previous year. The crop is estimated at about 120,000 tons. Favourable conditions have prevailed in Trinidad and a larger crop than in 1936 is anticipated.

The Sea Island Cotton Industry.

The fourth annual general meeting of the West Indian Sea Island Cotton Association was held in St. Kitts at the end of November, 1936, at which all Island Associations were represented. Among the more important matters considered at the meeting was the report on the work of the Advisory Committee in England, the main activities of which fall under trade mark administration, research and advertising.

The Association's trade mark has aroused much interest and certificates for the use of the mark have been issued to 69 applicants. The mark has become widely appreciated as a guarantee that goods are generally made from one hundred per cent. Sea Island cotton. Complaints, however, have been received by the Committee that goods sold at low prices would endanger Sea Island interests, but it is felt that this matter is beyond the control of the Committee.

The decision was arrived at during the course of the year that the use of the trade mark shall be limited to goods entirely manufactured within the British Empire. In order to give legal effect to this decision some changes require to be made in the regulations governing the issue of certificates for the use of the mark, and application is being made to the Board of Trade for approval of the proposed alterations.

In regard to the work undertaken by the Wool Industries Research Association, considerable progress can now be reported. The mixture yarn produced from 50 per cent. chlorinated wool and 50 per cent. Sea Island cotton has been shown to have twice the strength of an all-wool yarn, whilst retaining the appearance and feel of wool. Experiments have demonstrated that it is unshrinkable. The Advisory Committee has arranged for the spinning of a further quantity of this yarn with a view to its introduction for commercial use as soon as the Wool Industries Research Association release their chlorination process. It is expected that the yarn will have a special interest for hosiery manufacturers.

The Advisory Committee continued its endeavours to find new outlets for the consumption of Sea Island cotton and to extend the use of Sea Island cotton in other directions. The Committee has not advertised extensively during the past year, but a survey of retailers has been undertaken which is expected to provide valuable information for future developments.

As the result of a suggestion made by the meeting, efforts are being made for arranging weekly broadcasts of Sea Island cotton market information from London through the British Broadcasting Corporation.

The Association was incorporated under the Companies Ordinance, Chapter 180 of the Colony of Trinidad and Tobago in October, 1936. The Statutory Meeting of the West Indian Sea Island Cotton Association (Incorporated), was held in St. Kitts on 25th November, 1936. The registered office of the incorporated Association is at the Imperial College of Tropical Agriculture, Trinidad.

The first Ordinary General Meeting of West Indian Sea Island Cotton Association (Incorporated) was also held in St. Kitts at the end of November, 1936. The members of the Association at the date of this meeting were Antigua Cotton Growers' Association, Barbados Cotton Growers Association, Montserrat Cotton Growers' Association, and the St. Vincent Chamber of Agriculture and Commerce (Inc.). A representative from each Association attended the meeting. Mr. H. F. Shand of Montserrat and Mr. A. de L. Inniss of Barbados were appointed Directors for the ensuing year.

Owing to an unfavourable season in Montserrat in 1936, only 40 per cent. of the previous year's crop was produced in that Island. This crop shortage had a serious effect on total production in 1936 in the British West Indies, which amounted to 3,520 bales of 400 lb. each or some 1,000 bales less than the estimate at the beginning of the year. Production figures for 1936 are set forth in Table I.

Table I.—Production of Sea Island cotton in 1936.

Island.	Acreage.	Production in lb. lint.
Anguilla	400	29,434
Antigua	612	117,778
Barbados	247	9,594
Montserrat	4,550	400,000
Nevis	1,857	211,819
St. Kitts	1,030	232,000
St. Vincent	3,540	396,960
Virgin Islands	150	11,280
Total	12,386	1,408,865

The Association continued to adopt a policy of controlled production, and allocated a production quota to the respective Islands in accordance with the estimated requirements of the trade. The estimated production in 1937 is shown in Table II.

Table II.

Estimated Acreage and Production in 1936-37.

Island.	Acreage.	Production in lb. lint.
Anguilla	500	50,000
Antigua	937	140,550
Barbados	191	19,100
Montserrat	5,000	1,000,000
Nevis	3,000	300,000
St. Kitts	1,500	300,000
St. Vincent	5,000	400,000
Virgin Islands	250	25,000
Total	16,378	2,234,650

The West Indian Sea Island Cotton Association (Incorporated) agreed to invite the Governments of the Islands concerned to impose a cess of one farthing per pound on all clean cotton lint exported during the calendar year 1937, and to transfer the sum thus collected to the funds of the Association.

In accordance with the recommendations of the Association the Government of Fiji has undertaken to restrict the export of Sea Island cotton from that Colony to a maximum of 300 bales of 400 lb. each per annum for a period of five years ending 1940-41. It has also agreed to impose a cess of one farthing per pound on the cotton exported and to hand over the funds thus collected to the Advisory Committee in England. In these circumstances the Advisory Committee has arranged that the trade mark be used in respect of cotton exported from that Colony.

Banana Exports.

In the following table the quantity of bananas supplied by the various Island organizations to the Canadian Banana Company for the first ten months of 1935 and 1936 are set forth :—

Bananas Exported to the Canadian Banana Company for the Period January—October, 1935 and 1936.

	Trinidad.		Grenada.		St. Vincent.*		St. Lucia.		Dominica.		Total.	
	1935.	1936.	1935.	1936.	1935.	1936.	1935.	1936.	1935.	1936.	1935.	1936.
Nines	18,207	48,296	12,894	43,389	359	4,962	14,070	23,771	15,497	23,803	61,027	144,221
Eights	15,228	42,900	9,986	37,236	420	7,944	15,716	26,840	16,765	24,788	58,115	139,708
Sevens	16,846	45,840	10,903	44,120	628	12,290	15,576	32,092	17,973	28,198	61,926	162,540
Sixes	172	376	3,524	11,296	104	3,036	3,088	7,000	1,808	1,704	8,696	23,412
Total Stems	50,453	137,412	37,307	136,041	1,511	28,232	48,450	89,703	52,043	78,493	189,764	469,881
Equivalent Counts	39,090	103,485	26,716	96,200	1,014	17,824	33,667	61,806	37,507	56,914	137,994	336,229
Percentage Counts	78%	75%	73%	70%	66%	63%	70%	68%	72%	72%	72%	71%

* First shipment July, 1935.

Brevities.

Mr. P. E. Turner, Sugar-Cane Agronomist, visited St. Kitts and Antigua from 30th November to 27th December.

* * *

Mr. G. A. Jones, Commissioner of Agriculture, returned from leave on 17th October and resumed duty from that date.

* * *

At the Annual Stock Sale of the Trinidad Government Farm held on 5th December, purchases of stock were made on behalf of planters in St. Vincent and St. Lucia.

Mr. C. C. Skeete, Acting Commissioner of Agriculture, visited St. Lucia and Dominica, from 14th September to 7th October.

* * *

Mr. G. A. Jones, Commissioner of Agriculture, visited Antigua, St. Lucia, St. Kitts and Dominica from 9th November to 16th December.

* * *

Mr. F. A. Squire, Entomologist for Cotton Pest Investigation in the Windward and Leeward Islands, visited Montserrat from 15th September to 7th October.

Mr. C. C. Skeete, Assistant Commissioner of Agriculture, left on tour for St. Lucia, St. Kitts and St. Vincent on 10th November.

* * *

Mr. R. G. Fennah, Lecturer in Entomology, paid a brief visit to St. Lucia from 15th to 23rd September, to examine experiments already in progress for the control of citrus weevils (*Diaprepes*).

* * *

An event of agricultural interest and of an unprecedented nature occurred on 20th November when a party consisting of the Directors of the Trinidad Lime Oil Association and others interested in lime products proceeded to St. Lucia by special airplane to meet and discuss matters of mutual interest with the Lime Oil Association of St. Lucia. The party remained overnight in St. Lucia and returned the next day to Trinidad after completing a most satisfactory meeting in St. Lucia.

* * *

Mr. F. A. Squire, Entomologist for Cotton Pest Investigation in the Windward and Leeward Islands, proceeded to St. Vincent at the end of October and established his headquarters there for the period of the current cotton crop.

MOLASSES, NITROGEN FIXATION AND LAND RECLAMATION.

In his presidential address to the United Provinces Academy of Sciences, India, on 19th December, 1935, Professor N. R. Dhar gave a general account of the work carried out by himself and his collaborators on nitrogen transformations in soil. Professor Dhar leads the school of thought which believes that nitrification in soils and nitrogen fixation from the atmosphere are, especially in the tropics, photochemical at least as much as bacterial actions. Prof. Dhar has produced strong evidence in support of his theories, and the question appears now to have reached the stage at which the protagonists of bacterial and photochemical nitrification respectively are unwilling to admit any evidence which might shatter their beliefs.

Meanwhile, other soil workers will be wise to keep an open mind on the matter, for the philosophical implications of recognising that light plays a part in soils analogous to photosynthesis in the vegetable kingdom are at least as important as the practical possibilities of utilising that knowledge for the enrichment of the soil. Given sufficient facts, their practical application does not necessarily depend on their correct interpretation. The practical facts of Professor Dhar's researches are that Indian soils are generally deficient in nitrogen, that more than half a million tons of molasses from the sugar industry are annually wasted in India, and that the application of molasses to the soil can double and may treble the soil nitrogen content, with a consequent large increase in crop yield.

Molasses contains about 70 per cent. of carbohydrates and small quantities of nitrogen, phosphorus, potash, &c., these quantities, however, being much too small to account for the observed manurial effect. According to Professor Dhar, the energy set free in the oxidation of the sugars in molasses is utilised, either bacterially or photochemically, in promoting nitrogen fixation and nitrification. Whatever the nature of the process, Dhar has produced indisputable evidence of increases in available soil nitrogen and crop yield, following the application of molasses. Under temperate conditions, the converse result would be expected, as it is well known that the addition of carbohydrate-rich material to soil tends to reduce the amount of nitrogen available to plants the nitrogen becoming fixed as microbial protoplasm or as humus. An essential difference, however, between temperate and tropical soil requirements is that, whereas in temperate regions the limiting factor to crop growth is often the slowness, in the tropics it is the rapidity with which soil nitrogen is made available to plants, soluble nitrates being formed and leached from the soil before they can be absorbed by the crop. The general effect of molasses on the soil should be the same everywhere, but only in the tropics will its 'braking' effect on the mobilisation of soil nitrogen be a positive advantage to the cultivator, and only in the tropics will its stimulation of atmospheric nitrogen fixation, whether bacterial or photochemical, be appreciable, since temperate regions lack the heat necessary for bacterial and the light for photochemical stimulation.

For these reasons, the potentialities of carbohydrate manuring—of which molasses manuring is an example—have perhaps been overlooked by agriculturists. If Professor Dhar can substantiate his claims, he may effect a revolution in agriculture in India, where the supply of the ordinary organic manures is far below the demand. Professor Dhar suggests that a most valuable use can be made of molasses in reclaiming alkaline land. The acids produced in the decomposition of molasses neutralise the alkalis, and at the same time and contrary to experience when land is reclaimed with gypsum or sulphur, soil nitrogen is increased. A period of about four years is usually necessary to reclaim alkali land with gypsum, whereas with molasses applied at a rate of 30 to 40 tons per acre, good crops can be grown within six months. It is not stated whether such reclamations have been found permanent—in view of the oxidisability of the neutralising acids this is open to doubt—but the method obviously merits further study. There are four million acres of infertile alkali land in India, and irrigation practices are increasing the area. The economic reclamation of these lands is one of the country's greatest agricultural problems, to the solution of which Professor Dhar's work is pointing the way.—(*Nature*, Vol. CXXXVII, No. 3467, p. 629, 1936.)

REVIEWS.

THE CULTIVATED RACES OF SORGHUM.

By J. D. Snowden, F.L.S. Printed for the Trustees of the Bentham-Moxon Fund by *Adlard & Son*, London, 1936. pp. 274, price 10s. 6*d*.

The serious need for more detailed and systematic knowledge about the species, varieties, and races of our tropical crop plants has been repeatedly emphasised during the last few years. The volume before us is therefore welcome as a valuable contribution to our knowledge of a particularly complex group, and doubly so as the harbinger of an attack on problems of crop taxonomy organized on a wider basis than any yet launched.

This work is described in Sir Arthur Hill's preface as "the first attempt which Kew has made to carry out a systematic and detailed crop study in co-operation with the officers of the Agricultural Departments of the British Empire". A questionnaire was issued to the Directors of Agriculture in those parts of the British Empire where grain Sorghums are a staple crop, asking for information and specimens to be sent to Kew. In many countries, as a result, varieties were collected, grown and studied for this purpose, whilst at Kew the Trustees of the Bentham-Moxon Fund generously subsidized the full-time employment of a botanist to collate and classify the specimens sent in. The advantages of the method are obvious. It utilizes on the one hand a large and widely distributed organization for collection and field study, and on the other the resources of a centre well equipped for the critical herbarium and library studies that are an essential part of taxonomical research.

Until recently Economic Botanist in Uganda, Mr. Snowden started with the advantage of familiarity with the crop in the field, and his monograph is admirably done. Under each species are paragraphs on history, characteristics, affinities and distribution, and cultural and economic notes, as well as a botanical description and a keyed and annotated list of varieties and forms.

There will undoubtedly be criticism in many quarters of the decision to give the status of species to so many types, but it is difficult to suggest how the arrangement could have been bettered on any other basis. In future, instead of tagging "*Andropogon Sorghum* Brot." on to any type that may be under discussion, we shall have to specify one or other of 31 distinct species of *Sorghum*, which is more trouble, but the name will at least mean something, which the binomials at present loosely applied to our crops rarely do. The species also are subdivided into varieties and forms, and this detailed treatment makes the arrangement into numerous species convenient for reference, by reducing the number of names to be applied to each plant. Convenience is after all one of the main ends of classification, and so long as relationships are not obscured (which they certainly are not here) it matters little whether the specific limits are fixed wide or narrow. Further light on the status and interrelationships of the numerous forms concerned must come in the main from geneticists, and they have very many years of work ahead of them before the assemblage can be considered well understood.

The care which Mr. Snowden has devoted to the historical study of *Sorghum* is not the least of his services in the preparation of this revision, and his bibliography, containing at a rough estimate 500 entries will assist many workers beside those directly interested in the systematic part of the book. It scarcely needs to be added that this is mainly a reference book, and not a text to be read through, but there are chapters, such as those on general distribution and the relationships of the wild and cultivated Sorghums, that are not only readable but highly valuable as discussions.

E. E. C.

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THE COMING OF MAN.

By G. G. MacCurdy, Ph.D., *Chapman & Hall, Ltd.*, London. pp. 157, price 4*s*. 6*d*.

One can well appreciate the difficulties with which an expert is faced when called upon to write an account of his own subject which must be concise, as up-to-date as possible and devoid of technicalities. In writing this book Dr. MacCurdy has clearly had his share, and deserves congratulation on the way he has overcome them.

The first four chapters are devoted to fixing Man's position on the evolutionary canvas, and include some informative pages on the Primates with special reference to the features of most importance to the systematic pre-historian. The text is well filled with zoological data, but worded so simply as to make very easy going for the reader.

Fossil Man is given twenty-two pages, divided between two chapters. The details of the earliest human remains so far recovered are discussed, and, as the total number of skeletal fragments is small, it has been found possible to supply a very representative series of illustrations. The photographs and drawings of the reconstructed skulls are very helpful, but as the probable appearance of their former owners when alive is likely to arouse general interest at least as much as their anatomical structure, it is suggested that these already fascinating chapters would benefit by the addition of sketches affording an impression of the features of our Palaeolithic ancestors.

After Man himself, the history of his culture is considered. An introductory chapter on Chronology is followed by separate discussion of Palaeolithic, Mesolithic and Neolithic cultures, leading to the Bronze Age and the Iron Age. The remainder of the book gives brief sketches, with notes on the sources of information, of the most important aspects of man's activities, such as the obtaining of food,

shelter, protection, clothing, &c. In spite of the general paucity of fossil data, the picture is tolerably detailed in each case.

A brief bibliography is appended, followed by a glossary, which, though the text itself is freely supplemented by footnotes, is none the less very acceptable. The index, covering rather more than eight pages, has been carefully compiled, and its value is increased by a key to pronunciation.

The book as a whole is to be commended as a praiseworthy attempt to supply at a low price accurate information, couched in a readable style on the prehistoric stages of human development.

R. G. F.

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FIFTY YEARS OF FIELD EXPERIMENTS AT THE WOBURN EXPERIMENTAL STATION.

By Sir E. John Russell, D.SC., F.R.S. and Dr. J. A. Voelcker, C.I.E., M.A, *Longmans, Green & Co.*, London 1936, pp. 392, price 21*s*.

This book describes the classical agricultural experiments conducted at the Woburn Experimental Station, founded in 1876 by the Duke of Bedford and the Royal Agricultural Society, some 30 years after the Rothamsted Station had been inaugurated. The chief problem investigated at Woburn was the influence of farmyard manure, produced by live-stock fed with concentrated foods, on soil productiveness. In those early days, farm tenants, when they quitted their holdings, received no compensation for any improvement they had effected in the soil. The Woburn experiments were designed to yield quantitative information concerning the enhanced value of the land when highly farmed, so as to secure an accurate basis for compensation claims. In addition to this investigation, two other series of experiments were initiated, namely, the testing of the effect on soil fertility of growing wheat and barley continuously on the same land, and an examination of the value of green manures in wheat production.

The conduct of the Woburn experiments was carried on by Dr. Augustus Voelcker from 1876 to 1884 and afterwards, to 1926, by his son Dr. J. A. Voelcker. Subsequently the Committee of the Rothamsted Station assumed responsibility. Although the method of field experimentation employed at Woburn involved single plot treatments only (rather than randomised replicated plots), recent statistical procedures have been devised at Rothamsted whereby single-plot data can be mathematically examined so as to furnish reliable conclusions concerning yield trends. The second part of the book presents the results of such statistical examination undertaken by Miss A. M. Webster and W. G. Cochran. It has demonstrated (*a*) that nitrogenous manures are necessary to continued high production of wheat and barley grown in sandy soil under the prevailing climatic conditions, (*b*) that lime is needed when sulphate of ammonia is used frequently, (*c*) that green manuring is liable to failure even on soils where it would be expected to succeed, and (*d*) that serious losses are likely to occur when rich farmyard manure is applied to the soil, or when cake is fed to sheep folded on the land.

The first part of the book is an account by Dr. J. A. Voelcker of the experiments as a whole, and the third part is a discussion by Sir E. J. Russell of the experimental results and their bearing on agricultural science and practice. The soils of the Woburn Station and the changes that have occurred in them during the course of the experiments, are described by Dr. E. M. Crowther in the fourth part of the book; the data themselves are tabulated in an appendix, and a full index completes the work.

As an authentic historical and scientific record of a famous series of experiments, the book leaves nothing to be desired. It is a model of lucidity and clear reasoning, and as such it may be recommended to agricultural students to whom the fundamentals of their subject have a philosophical appeal.

F. H.

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NORTH AMERICA, CENTRAL AMERICA AND WEST INDIES.

By Thomas Pickles, *J. M. Dent & Sons Ltd.* London, 1936. pp. 276, price 2*s*. 6*d*.

As indicated in the preface, this handbook has been written primarily for pupils approaching matriculation or school certificate standard. The subject matter is divided into 19 chapters of which one is allotted to Newfoundland, six to Canada, seven to the United States, one each to Mexico and Central America, and two to the West Indies.

After a comprehensive survey of the region as a whole, ably condensed into 27 pages (forming the longest chapter), the physiographical units which form Canada and the United States are dealt with severally. The text, always highly factual, is nevertheless very readable: attention is devoted principally to topography and industry, though where their insertion has been thought useful, a few historical and political notes have been added.

In the 49 pages dealing with Central America and the West Indies, political divisions are described separately, since each is largely a topographical entity. Although it is clear that if given proportionate attention the Central American republics cannot be accorded much space, it is here that it would seem that condensation of fact has reached its limit. Most of such notes as are given are concerned with an analysis of the topography of each locality.

The illustrations consist mainly of simplified diagrams which are definitely informative; in addition the twelve plates are unusually good for a book of this type, all being well chosen, and including five aerial photographs. The matter of the book is up-to-date, and well presented. The available space has been thoughtfully utilized, and the account appears sufficiently adequate to fulfil the purpose for which it was written.

R. G. F.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Juice Analysis in Relation to Fertilizer Requirements of Barbados Soils. *By S. J. Saint.*

Selected varieties of sugar-cane, grown on trial plots in various districts of the island of Barbados in different years, were analysed. From the extensive data collected, it is concluded that under Barbados conditions, the analyses of sugar-cane juice would be of little value in determining possible soil deficiencies. However the figures allow of certain correlations of interest.

There is a high positive correlation between analytical figures obtained from cane and from juice indicating that any conclusions arrived at from a study of juice analyses can be applied equally to cane analysis. In other words, the various constituents are distributed between juice and bagasse in definite ratios, and these ratios are very similar for different varieties and different years. Although the analytical ratios are fairly well maintained in all varieties, the actual composition of the mineral matter of different varieties is different. The composition of the juice of a given variety grown under similar soil conditions may vary from year to year under different climatic conditions; this appears to apply more especially to the percentage of phosphoric acid in the juice. Under similar soil and climatic conditions, varieties show a differential absorption of potash from the soil and in certain cases, phosphatic manuring appears to increase the percentage of potash in the juice. Sugar-cane growing on soil deficient in potash may have a greater percentage of potash in the juice than cane growing on soil not deficient in potash. On the other hand, increases in the potash manuring are followed by increases in the percentage of potash in the juice. Under Barbados conditions, phosphatic manuring does not appear to increase phosphoric acid percentage in the juice.—(*Facts about Sugar*, Vol. XXXI, No. 4, p. 149, 1936.)

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South African Committee on Standardization of Chemical Control (Polarization of Mixed Juice; Sucrose Determination; Reduced Extraction Figure). *By H. H. Dodds.*

Pol. of Mixed Juice.—Further experience with this procedure has been entirely satisfactory, and it is now recommended by the Committee for adoption for general use, thus replacing the Schmitz 100-110 ml. dilution method. In operating it, five times the normal weight (130 grms.) of the juice are weighed into a 200 ml. flask, made up to the mark with water, treated with Horne's dry lead, filtered, de-leaded, and polarized in the 400 mm. tube.

Pellet Tube.—The Committee had under consideration the adoption of the Pellet tube for the rapid polarization of samples of crusher juice, but desires to gain further experience before definitely recommending it.

Sucrose Determination.—Jackson and Gillis' Method No. 4, for the determination of sucrose by double polarization, had again been subjected to exhaustive comparative tests in several laboratories in Natal, and found entirely satisfactory. Accordingly, the Natal Sugar Millers' Association have been urged to sanction its adoption for all factories.

This investigation had raised the question of the possible muta-rotation of the sugar inverted under the conditions of the test. There may be a tendency for the attainment of the normal rotation to be delayed, and it is therefore recommended that the inverted solution be allowed to stand for half-an-hour before its reading.

Reduced Extraction Figure.—The Committee had by a majority decided to adopt Noel Deerr's "reduced extraction" figure, but not his proposal to calculate the relative efficiency of the operation of different mills by taking into account the degree of imbibition, size and number of milling units, and the average content of the cane.—(*Inter. Sugar Journal*, Vol. XXXVIII, No. 453, p. 350, 1936.)

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Flowering of Different Varieties of Sugar-Cane. *By B. T. Baretto.*

The conclusions reached in this study in Cuba are that the factors influencing the flowering of sugar-cane are unknown, but it is evident that the new seedlings obtained from true seed have a tendency to arrow abundantly, as P.O.J. 2725, P. 28 and M.7. A year of great rainfall seems to be accompanied by an increase in arrowing even in such varieties as P.O.J. 2714, 2878, and 2883; under ordinary conditions these varieties do not flower. In soils that have a high water-table, the flowering of P.O.J. varieties is retarded, whereas according to Calvino, the Cristalina variety flowers in Camaguey and Oriente, Cuba, even more abundantly than in the drier soils. Artificial measures of control are not recommendable in Cuba, where varieties that show a percentage of flowering in excess of 30 per cent. should be abandoned.—(*Facts about Sugar*, Vol. XXXI, No. 4, p. 150, 1936.)

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Analysis of Lime and Limestone; *by E. S. Gavrilenko.*

In developing a general system for the analysis of lime and limestone, the author uses a volumetric method for the determination of calcium carbonate and magnesium carbonate.. In this method, calcium is precipitated as oxalate, and magnesium is precipitated in the same solution by means of sodium arsenate. The precipitate is filtered off, dissolved in sulphuric acid, and titrated with permanganate solution in order to determine calcium. In the same solution, arsenic is determined iodometrically.—(*Facts about Sugar*, Vol. XXXI, No. 8, p. 312, 1936.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Composition of Savannah Grass.

Savannah Grass or Carpet Grass (*Axonopus compressus*), is a common natural pasture grass of tropical humid countries. Recently an investigation of its chemical composition and variability has been made by Mr. C. D. V. Georgi, Agricultural Chemist of the Department of Agriculture, Federated Malay States (*see Malayan Agric. Jr.* XXIV, 8, pp. 393-396). In Malaya, cattle do not relish this grass, and often develop intestinal troubles when fed on it, possibly because of the occurrence of hydrocyanic acid in the grass. Accordingly, samples of the grass grown at the Serdang Experiment Station, were analysed; the samples were taken from plots cut at intervals of 4, 5 and 6 weeks respectively over a period of 4 months. An abstract of the analytical data is given in the following table, together with data for Guinea Grass (*Panicum maximum*) also grown in Malaya.

	Carpet Grass (*Axonopus compressus*).			Guinea Grass *Panicum maximum*).		
	Four weeks	Five weeks	Six weeks	Four weeks	Five weeks	Six weeks
	Percentage of oven-dry matter.					
Crude Protein....	8.3	7.5	7.5	12.3	10.8	10.1
Crude Fat	1.7	1.4	1.4	—	—	—
Crude Fibre	30.5	30.8	30.8	30.0	29.9	29.9
Total Ash	6.0	5.9	5.8	—	—	—
Lime (CaO)	0.5	0.5	0.5	—	—	—
Phosphate (P_2O_5)	0.5	0.5	0.4	—	—	—
	Percentage of fresh matter.					
Moisture Content of Fresh Grass	71.1	69.3	69.3	76.3	74.9	74.9
	Parts per million of fresh matter.					
Hydrocyanic acid content (HCN)	13	13	10	14	9	9

The *moisture content* of Carpet Grass is evidently considerably lower and liable to greater variation than that of Guinea Grass grown in Malaya, which may account for its lesser palatability. Carpet Grass contains less *protein* than Guinea Grass, but the *fibre content* is about the same in both. Protein contents diminish with age in each case. *Hydrocyanic acid content* is about the same in Carpet Grass as in Guinea Grass.

Edible Gelatin.

Gelatin is not generally regarded as having any particular food value. It is classified as an incomplete protein in view of the fact that its cleavage products do not include tryptophane, and only very small amounts of cystine and tyrosine. Evidence supports the view that the absence of these amino acids renders gelatin a protein which cannot be used as a sole source of protein food for any length of time. However, some years ago, in face of this somewhat disheartening position, a number of the leading gelatin manufacturers of America financed a comprehensive research, conducted by Dr. T. B. Downey at the Mellon Institute, to make out the best possible case for the "food value and dietetic properties of edible gelatin"—and the results were surprisingly good in view of the circumstances. The main conclusion reached is that the greatest benefits from edible gelatin are to be obtained by combinations with other foods. It is an exceedingly efficient supplementary protein food, easily digested and absorbed, and it materially aids in the digestion of other food products (milk being a notable example), by virtue of its colloidal and emulsifying effects. This is stated to have been abundantly proved by experiments. In addition, gelatin is held to be peculiarly fitted for hospital dietaries.—(*Food*, Vol. VI, No. 61, p. 28, 1936.)

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Vitamin C in Orange and Tomato Juices.

Orange juice contains from two to three times as much vitamin C as tomato juice. Either of the juices loses vitamin C if allowed to stand before using. These results are announced by workers in the Bureau of Home Economics, United States Department of Agriculture, in an article published in the *Journal of Home Economics*. The bureau points out, however, that when tomato prices are much lower than orange prices, it may be possible to get as much or more vitamin C protection per dollar from tomatoes.

The tests included both chemical analysis and feeding trials of four varieties of oranges—two from California and two from Florida—fresh pressed juice of tomatoes and juice from a brand of commercial canned tomatoes. The investigators found that canned tomatoes contained as much vitamin C as the fresh sample.

The common household custom of squeezing orange juice at night to serve at breakfast causes a loss of 10 per cent. or more of its vitamin C value, even though it stands covered in a refrigerator. Tomato juice from fresh or canned tomatoes also deteriorates when allowed to stand exposed to the air. This may amount to as much as 40 per cent. loss if the juice stands for several days.—(*Industrial and Engineering Chemistry, News Edition* Vol. XIV, No. 18, p. 380, 1936.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.)

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
29th October	4	10½	8	6¾
5th November	4	10½	8	7½
12th November	4	11¼	8	8¼
19th November	4	9¾	8	6¾
26th November	4	9¾	8	6¾
3rd December	4	9¾	8	6¾
10th December	4	9¾	8	6
(*12th December*, 1935)	5	0¾	8	9

After ruling very steady and comparatively active the market has assumed a decidedly quieter tone and prices have shown a decline of 1½*d.* per cwt. Although there is no change in the supply situation as far as full duty sugars are concerned the persistent lack of interest among regular large buyers has made itself felt. In America growing optimism concerning the future sugar situation has brought a firmer tendency to the New York market.

* * *

RUBBER.—Quotations for plantation sheet have ranged as follows:—

	Pence per lb.
28th October	8 1-8
4th November	8 3-8
11th November	8 5-8
18th November	8 3-8
25th November	8 3-4
2nd December	8 7-8
9th December	9 1-16
(*11th December*, 1935)	6 3-8

The market has been firm and active following upon the decision of the International Regulation Committee to raise the export quota from 65 to 70 per cent. for the first six months of this year. Prices have shown substantial advances as a result of a good trade demand and a further drop in United Kingdom stocks. American consumption for October was 49,509 tons and for the first ten months of 1936 amounted to 473,590 tons as against 411,429 tons for the same period in 1935.

* * *

BANANAS.—The demand has been slow owing to cold and wet weather. Jamaicas are £1 lower at £17 5*s.* per ton delivered London and £17 nearest station. Brazilians have declined by a similar amount to £14 London and £15 Provinces. —(*West India Committee Circular*, 19th November.)

* * *

COPRA.—The market is very firm with West Indian f.m.s. quoted nominally at £2 5*s.* 0*d.* per ton higher or £17 15*s.* 0*d.* c.i.f. London.—(*West India Committee Circular*, 19th November.)

COCOA.—During the past month the cocoa market was very firm and reached new high price levels. The knowledge of the shortage of the Bahia crop and the indication of a considerable shortage in the New African Crops are being realised and felt throughout the Trade, particularly, since the consumption is even greater than expected. The soundness of the situation now seems to be fully realised by everyone, and a much higher level of prices appears likely. Accra is quoted at 50*s.* 3*d.* and locally $16.00 a fanega is paid for plantation cocoa.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
30th October	6.81	11.42
6th November	6.92	11.36
13th November	6.71	11.72
20th November	6.76	11.29
27th November	6.72	—
4th December	6.81	—
11th December	6.93	—
(*13th December*, 1935)	6.50	9.66

Quotations have been somewhat irregular and the tendency easier although trade has been fair. It is now believed that the final yield of the American crop will exceed preliminary estimates. There has been a reaction in Egyptian Sakel quotations as a result of liquidations by leading operators in the Liverpool market. Demand for West Indian Sea Island continues strong and all offers have been absorbed quickly.

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COFFEE.—There has been a small supply of good qualities which are in request at full prices; recent quotations include Superior Santos at 45*s.* 9*d.* per cwt. f.o.b. terms; Kenya new crop bold greyish-greenish, 70*s.* 6*d.* 110*s.* 6*d.*; Costa Rica, bold size London cleaned 59*s.* to 70*s.*

* * *

LIME PRODUCTS.—*Lime Oil.*—Small sales of fine quality Handpressed have been reported at 35*s.* to 37*s.* 6*d.* There are sellers of distilled at 22*s.* 6*d.* but the demand is slow. *Lime Juice.* There is no demand for Concentrated and Raw remains unchanged at 2*s.* to 2*s.* 6*d.* according to quality.—(*West India Committee Circular*, 19th November.)